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# EDITORIAL REPORT ON NOMENCLATURE, 1952.*

## Inorganic

*Poly-acids.*—Reference was made in the 1950 Report (*J.*, 1950, 3699) to the use of the names, di-, tri-, and tetra-sulphuric acid for $H_2S_2O_7$, $H_2S_3O_{10}$, and $H_2S_4O_{13}$, respectively. This use has proved convenient also in later papers (*e.g.*, *J.*, 1952, 3916), as has a similar use for phosphorus poly-acids, *viz.*, $Na_3P_3O_9$ sodium trimetaphosphate and $Na_4P_4O_{12}$ sodium tetrametaphosphate (*J.*, 1952, 1314, 1317).

*Nitrogen Acids*—The name, sodium oxyhyponitrite, has been used for the compound $Na_2N_2O_3$, of which two forms, designated α- and β-, exist (*J.*, 1952, 338, 346); the name is derived formally from sodium hyponitrite, $Na_2N_2O_2$, structural implications being avoided.

*" Lyate-ion " Salts.*—Salts of which the anion is identical with the anion of the solvent have been termed " lyate-ion " salts (*J.*, 1952, 2494).

## Organic

Three developments in organic nomenclature during 1952 have maximum importance. The rules mentioned in 1, 2, and 3 below have been approved by the Chemical Society for use in its publications, and *nomenclature in all manuscripts submitted henceforth should conform to these rules.*

1. *I.U.P.A.C.*—The first instalment of the revision of the Definitive Report by the Commission of Nomenclature of Organic Chemistry has been published by I.U.P.A.C. in its final form. The whole of the organic rules, embodying both the old and the new rules, is printed as Appendix 1 (p. 5064) of this issue. It is hoped to print in these Editorial Reports on Nomenclature the whole set of rules in their most modern form each time that a major definitive revision is officially adopted by I.U.P.A.C. The rules printed in Appendix 1 are accompanied by comments by the Editor (of the Chemical Society) which are designed (*a*) to indicate how old rules not yet revised are affected by revision of other rules, (*b*) to explain the changes required in British nomenclature, and (*c*) to comment on certain of the older rules with particular reference to British nomenclature.

A considerable number of small changes is involved, but all authors should note particularly the following two points of general application :

(*a*) " Oxo " is to be used in place of " keto " when the oxygen atom of a CO group is specified by means of a prefix in the name of a compound; " keto " continues in use only for generic descriptions (see p. 5072).

(*b*) Groups $CO_2R$, when named as prefixes, are to be designated on the pattern of methoxycarbonyl (not carbomethoxy) (see p. 5087). This does not however imply abandonment by the Society of the principle of substitutive rather than additive nomenclature; this matter is discussed in greater detail on p. 5061.

2. *Carbohydrates.*—A series of rules for the nomenclature of carbohydrates has been agreed by Committees of the British and American Chemical Societies. Important changes are involved for both countries. The new rules are printed in full in Appendix 2 (p. 5108) and come into force forthwith. Further aspects of carbohydrate nomenclature are under discussion between the British and American Committees.

3. *Organophosphorus and Allied Compounds.*—A series of rules for the nomenclature of organophosphorus and allied compounds has been agreed by Committees of the British and American Chemical Societies, and further aspects are under discussion. The agreed rules concern compounds containing one atom of phosphorus, arsenic, or antimony; they are printed in full in Appendix 3 (p. 5122) and came into force in October 1952 when their availability as preprints was announced in the Society's *Proceedings*. The principal changes from previous British nomenclature (*J.*, 1951, 3516) are for compounds in which halogen or nitrogen is linked directly to phosphorus, arsenic, or antimony. " Carbon acids " which are both acids and imides, *i.e.*, contain the group $-C(:NH)\cdot OH$ are termed imidic acids (cf. *J.*, 1950, 3702). In

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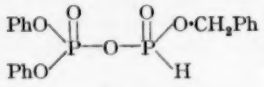
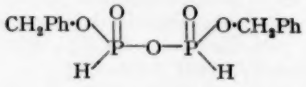
the same way, phosphorus acids which can be considered both (i) as acids and (ii) as acid halides, amides, or imides, have terminations such as -phosphonochloridic acid, -phosphinamidous acid, and the like. The rules and examples should be studied for the logical extension of this principle to the whole field.

*Mixed Pyrophosphoric Esters.*—The naming of the mixed ester (I) (*J.*, 1952, 3670) presented some difficulty because, pending the outcome of British-American discussion about compounds containing more than one phosphorus atom, it was desired to avoid creation of a novel precedent.

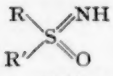
(I) 

 (II)

Accordingly, a mixed anhydride nomenclature was used, (I) being named *O*-benzylphosphorous *OO*-diphenylphosphoric anhydride. The symmetrical ester (II) was conventionally named dibenzyl pyrophosphite. It is hoped that similar nomenclature may suffice at least until British–American accord is reached.

*Organo-silicon Compounds.*—Details of the nomenclature of these are given in I.U.P.A.C. rules 70.1—70.20 (p. 5077).

*Sulphur–Nitrogen Compounds.*—A logical nomenclature for a series of such compounds has been propounded (*J.*, 1952, 1572). The name sulphoximine was earlier adopted (*J.*, 1950, 2081, 3701) for the series (III), being a contraction of sulphoxidimine which follows by analogy with phosphinimine $R_3P{:}NR'$. The compounds (IV) thus become *SS*-dialkyl-*N*-toluene-*p*-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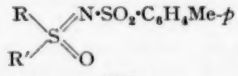
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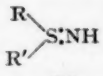
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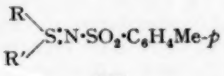

(VI)

sulphonylsulphoximines. Substances derived from the (unknown) parent (V), hitherto called dialkylsulphilimines, are renamed dialkylsulphidimines, by a similar analogy; the stable compounds (VI) then become *SS*-dialkyl-*N*-toluene-*p*-sulphonylsulphidimines.

The older name sulphilimine was used in a later paper (*J.*, 1952, 2792) which however was submitted before the above proposals were published.

*Epidioxides.*—The word epoxide or prefix epoxy is the correct designation for an oxygen atom attached to two different carbon atoms of the *same* carbon skeleton. Consequently, the systematic names epidioxide and epidioxy should be used in place of peroxide and peroxy for similar linkage of carbon atoms by means of $-O_2-$ (cf. *J.*, 1952, 4883, 4890, 4894).

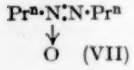
*Thiolsulphonic Acids.*—Acids, $R{\cdot}SO_2{\cdot}SH$, have been named thiolsulphonic acids (*J.*, 1952, 3728), by analogy with thiolcarboxylic acids, R·CO·SH (I.U.P.A.C. rule 30, p. 5068).

*Carbohydrates.*—For the new British–American rules see Appendix 2, p. 5108. The following additional points may be noted.

The trivial name phenylosotriazole was used (cf. Haskins, Hann, and Hudson, *J. Amer. Chem. Soc.*, 1946, **68**, 1766) to describe the derivatives of 2-phenyl-2 : 1 : 3-triazole which are obtained by the action of copper sulphate on sugar phenylosazones, $C_{(1)}$ and $C_{(2)}$ of the parent sugar forming part of the triazole ring, *e.g.*, glucose phenylosazone ⟶ glucose phenylosotriazole (2-phenyl-4-D-*arabo*tetrahydroxybutyl-2 : 1 : 3-triazole) (*J.*, 1952, 4993).

*Cyclitols.*—Proposals for the nomenclature and numbering of cyclitols were made (*J.*, 1952, 686), but pending international discussion were restricted to the necessities of the chemistry under discussion in the particular paper, which should be consulted for details. For a minor modification of customary symbolism see *J.*, 1952, 738.

*Aliphatic Azoxy-compounds.*—" Symmetrical " aliphatic azoxy-compounds were named by analogy with azoxybenzene (*J.*, 1952, 4191). Thus, (VII) was termed 1-azoxypropane, (VIII)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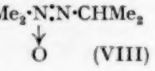
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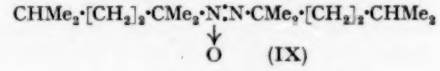
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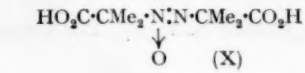
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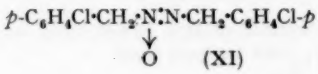
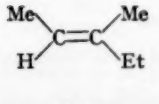

(XI)

2-azoxy[illegible]ane, (IX) [illegible]-azoxy-2 : 5-dimethylhexane, (X) α-azoxy*iso*butyric acid, and (XI) ω-azox[illegible]chlorotolue[illegible].

β-*Amino-acids*.—T[illegible] am ino-acids isomeric with thyronine and thyroxine were named β-thyronine and β-thyroxine, respectively (*J.*, 1952, 827).

cis-trans-*Isomerism*.—The rules which have received " tentative " approval by I.U.P.A.C. (Compt. rend. of the 16th Conference, 1951, p. 102) are being used in the *Journal* pending a final ruling. They are exemplified by the names 2-methylpent-*trans*-2-ene for (XII) and 3-*tert*.-butylhexa-*cis*-2 : *cis*-4-diene for (XIII), *cis* and *trans* having relation to the backbone.



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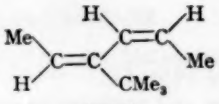

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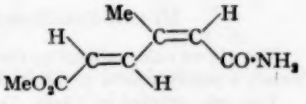


(XIV)

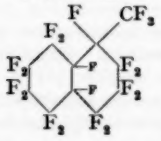
A somewhat different method was required (*J.*, 1951, 3387 and later papers) for the special case of muconic acid derivatives where the trivial name made the above inapplicable. It may be illustrated by β-methyl-*cis-trans*-muconic α-amide δ-methyl ester for (XIV), the terms *cis* and *trans* being cited in positional order, *i.e.*, the first cited referring to the lower-numbered double bond.

*Per*.—The American Chemical Society has adopted the following rule on a tentative basis (*Chem. Eng. News*, 1952, **30**, 4514) :

" The terms ' perbromo,' ' perchloro,' ' perfluoro,' and ' periodo ' may be applied to organic compounds or groups and shall denote substitution of all hydrogen atoms attached to carbon atoms except those whose substitution would affect the nature of the functional groups present. ' Per ' may refer to the whole word or to part of the word to which it is attached, but not to more than one word. Parentheses should be used where necessary to avoid ambiguity as to whether ' per ' refers to part of a name or to a whole name.

" *Examples* :

| | |
|---|---|
| $C_6F_{11}\cdot CF_3$ ..... | perfluoro(methyl*cyclo*hexane) |
| $C_3F_7\cdot CHO$ ..... | perfluorobutyraldehyde |
| $C_2H_5\cdot CO\cdot O\cdot C_4Cl_9$ ..... | perchlorobutyl propionate |
| $CBr_3\cdot CBr_2\cdot CH{:}N\cdot OH$ ..... | perbromopropaldoxime |
| $(CCl_3)_2CCl\cdot[CCl_2]_3\cdot CCl_3$ ..... | perchloro-(2-methylhexane) |
| $C_6H_5\cdot C_5Cl_{11}$ ..... | (perchloropentyl)benzene |



perfluoro(decahydro-1-methylnaphthalene)

" It should be noted that this use of ' per ' excludes names in which ' per ' is preceded by other prefixes. Thus $CF_3\cdot CClF\cdot CF_3$ would be called 2-chloroheptafluoropropane and not 2-chloroperfluoropropane. The reason for this limitation is to avoid the implication that some other atom rather than hydrogen has been substituted."

This rule will be adopted in our publications, pending discussion by I.U.P.A.C.

The use of perhydro to denote complete hydrogenation is, of course, of long standing.

*Use of " H " to designate the Positions of Hydrogen in almost completely Halogenated Organic Compounds*.—The American Chemical Society has adopted the following rule on a tentative basis (*ibid.*, p. 4515) :—

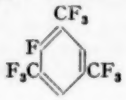
" In halogenated compounds or groups the position of the hydrogen atoms may be indicated by a prefix if the following conditions are met :

" **1**. The hydrogen atoms are not part of a functional group.

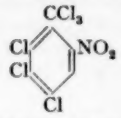
" **2**. Ordinarily the number of such hydrogen atoms will be not greater than four and the ratio of such hydrogen atoms to the halogen atoms which are of a single kind and not part of a functional group will be not greater than **1 : 3**.

" This prefix shall consist of the numbers of the carbon atoms to which the hydrogen atoms are attached, each followed by the letter *H*.

" *Examples* : $CHF_2{\cdot}CF_2{\cdot}CF_2{\cdot}CHF{\cdot}CF_3$ ..... 1*H* : 4*H*-decafluoropentane
$CHClF{\cdot}CF_2{\cdot}CF_3$ ..... 1*H*-1-chlorohexafluoropropane
$CHF_2{\cdot}CF_2{\cdot}CF_2{\cdot}CF_2{\cdot}CO_2H$ ..... 5*H*-octafluorovaleric acid
$C_6F_{13}{\cdot}CHF{\cdot}CHF{\cdot}C_6F_{13}$ ..... 7*H* : 8*H*-octacosofluorotetradecane



2*H* : 4*H*-Decafluoromesitylene

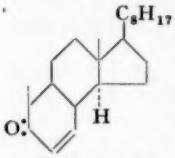


3*H*-Hexachloro-2-nitrotoluene

The above rule, subject to the rigid limitations laid down in it, may be used in the Chemical Society's publications, pending a decision by I.U.P.A.C.

The rule printed in *Chem. Eng. News* (*loc. cit.*) envisages its occasional extension to highly substituted derivatives where the substituents are not halogens, and also includes an example incorporating also the use of *H* for " extra " (" indicated ") hydrogen in a ring. In our Society's publications however the use of *H* in the sense of this rule will be restricted to the cases covered by the wording cited above.

*Des-steroids*.—The problem arose of naming compounds containing three of the steroid rings, each of known stereochemistry, in such a way as to show the structural and stereochemical relation to the steroids. For this purpose, cholestane stripped of the four methylene groups of ring A was termed des-A-cholestane, and the sterol numbering was retained (des was preferred to de, in this exceptional case, so as to avoid ambiguity in speech—des-D is preferable to de-D) (*J.*, 1952, 1224). An example is des-A-cholest-6-en-5-one (inset) [systematic name, which does not specify the configuration : 1-(1 : 5-dimethylhexyl)-$\Delta^{1'}$-decahydro-7*a* : 4′-dimethyl-3′-oxo-4 : 5-benzindene].



*Triterpenoids*.—After appropriate consultations, the hitherto general pictorial representation of triterpenes has been reversed and conventions have been defined for denoting the stereochemistry of the various asymmetric centres. These forms should be followed in the Society's publications. The original paper (*J.*, 1952, 2862) should be consulted for details.

*Arene*, *Arylene*.—These terms are acceptable within the limits of the following definitions adopted by the American Chemical Society (*Chem. Eng. News*, 1952, **30**, 4513).

Arene : Any aromatic hydrocarbon. The term aromatic hydrocarbon denotes any hydrocarbon in which at least one benzene ring is present. Examples : benzene, butylbenzene, styrene, phenylacetylene, phenyl*cyclo*hexene, terphenyl, indane, naphthalene, dihydroanthracene, *cyclo*pentenophenanthrene, pyrene, hexacene.

Arylene : Any bivalent radical derived from an aromatic hydrocarbon by removal of a hydrogen atom from each of two carbon atoms of the nucleus. Examples : phenylene, naphthylene, diphenylene.

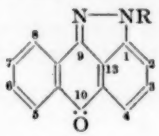
*Heteroaromatic*.—The term heteroaromatic has been used, as an adjective, in cases when a group CH (or, when appropriate, $CH_2$) of a ring of an aromatic compound is replaced by an atom other than carbon. This may be made more specific, as in, *e.g.*, *N*-heteroaromatic (pyridine, pyrimidine ; *J.*, 1952, 1461, 2911) or *S*-heteroaromatic (thiophen).

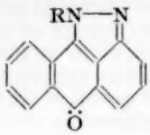
It will be noted that there is some conflict between this usage and the American definition of an aromatic hydrocarbon inasmuch as use of the American definition in application of the term heteroaromatic would exclude five-membered ring compounds. This difference will not be pursued at present.

spiro-*Compounds*.—The nomenclature outlined for *spiro*-compounds in last year's Report (*J.*, 1951, 3517) has proved useful in further cases (see, *e.g.*, *J.*, 1952, 866 *et seq.*, 1436, 4351, 4523).

*Heterocyclic Compounds*.—For a compound formally derived by three-carbon fusion of pyrazole and anthrone skeletons, no decision was possible between formulæ (XV ; R = H) and (XVI ; R = H). The indeterminate name 1 : 9-pyrazoloanthrone was therefore used (*J.*, 1952,

(XV)

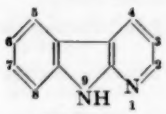


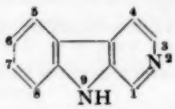


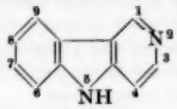
(XVI)

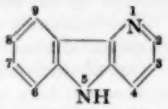
1630). However, the two *N*-methyl derivatives (R = Me) were also obtained and their constitutions were proved; systematic names were used for these, *viz.*, (XV) 1′-methylpyrazolo(2′ : 4′ : 3′-1 : 13 : 9)anthrone and (XVI) 1′-methylpyrazolo(3′ : 4′ : 5′-1 : 13 : 9)anthrone.

Carbolines have been named and numbered in a remarkable variety of ways. The method now current in the *Journal*, with the object of minimising obscurities, is to distinguish the four


(XVII) α-


(XVIII) β-


(XIX) γ-

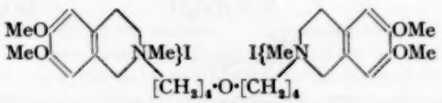

(XX) δ-

isomers as α-, β-, γ-, and δ-carboline (XVII—XX) and to use Ring Index numbering, as shown (cf. *J.*, 1952, 650).

In many other cases also, Ring Index numberings (and names) continue to prove both useful for clarity and desirable for uniformity.

Alkaloid chemists will note recent clarification of nomenclature of thebaine derivatives (*J.*, 1952, 958, 969).

*Oxa-aza-nomenclature in the Aliphatic Series.*—Use of the oxa-aza-nomenclature for aliphatic compounds has not been sanctioned by I.U.P.A.C., but occasionally proves very useful. For instance, the compound (XXI) was named 5-oxanonamethylenebis-2 : 2′-(1 : 2 : 3 : 4-tetrahydro-6 : 7-dimethoxy-2-methyl*iso*quinolinium iodide), and a similar system was used for its hexamethoxy-analogue, uniformity being thus retained with numerous analogues containing an " unbroken " central carbon chain (*J.*, 1952, 1311).


(XXI)

*Isotopically Labelled Compounds.*—The nomenclature outlined in last year's Report (*J.*, 1951, 3516) continues to prove useful and adaptable. Some self-explanatory examples are: ε-benzoyl-L-[α-$^{15}$N]lysine, [*carboxy*-$^{14}$C]lysine, [α-$^{14}$C]lysine, methyl 2-keto*cyclo*hexane-1-[$^{14}$C]-carboxylate, ethyl phthalimido[α-$^{14}$C]malonate, DL-[*carboxy*-$^{14}$C]tyrosine (*J.*, 1952, 1329, 3464).

*Conformation, Constellation.*—These two words have been used with the same significance in discussions of three-dimensional representations. Constellation has an astronomical meaning which is foreign to, and in some respects inconsistent with, the desired interpretation; accordingly, conformation should be used in the Society's publications. On the other hand, conformation is stated to have no steric significance in certain Continental languages, *e.g.*, German, and so constellation will perhaps continue to be used in these languages.

*Carbinol.*—Carbinol has been used as a name for the parent group $CH_3{\cdot}OH$ in substituted compounds of the type CRR′R″·OH where sometimes one or two of the groups R is H. Thus, diphenylcarbinol has been used for $CHPh_2{\cdot}OH$, ethylpropylcarbinol for CHEtPr·OH, triethylcarbinol for $CEt_3{\cdot}OH$. Such nomenclature is very rarely justified under modern conditions; now that methanol is universally recognised as denoting $CH_3{\cdot}OH$ it can normally be used in place of carbinol without loss of clarity; thus, diphenylmethanol is immediately intelligible, as well as being I.U.P.A.C. nomenclature (p. 5096); hexan-3-ol is immediately recognisable as CHEtPr·OH; triethylmethanol is as descriptive as, and no more incorrect than, triethylcarbinol, admittedly more descriptive than the correct name 3-ethylpentan-3-ol (which should however also be given at least once for indexing). The carbinol names are occasionally useful when discussing a *series* of such compounds, but should otherwise be avoided. Further, carbinol as a class name can always be replaced by the accurate " alcohol." Carbinyl (to denote the radical) is not permitted.

*Substitutive* v. *Additive Nomenclature.*—In systematic organic nomenclature, substituents are named as prefixes or suffixes attached to the name of the parent compound. Simple examples are nitrobenzene, *m*-dinitrobenzene, 2 : 4-dinitroaniline, 1-chloro-3 : 5-dinitrobenzene, hexan-2-ol, hexanoic acid, benzenesulphonic acid, naphthalene-1 : 5-disulphonic acid, 2-chloro-*cyclo*hexanecarboxylic acid.

Such names are compounded of (*a*) one parent name, which by itself specifies a compound capable of independent existence, and (*b*) one or more names of substituent groups which have

no independent existence (except sometimes as radicals or ions). Use of prefixes or suffixes in this way implies that one hydrogen atom of the parent compound is replaced by each substituent group; therein lies the criterion of " substitutive " nomenclature.

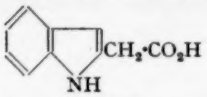
If a substituent is itself substituted, the same principle applies: amino- denotes $NH_2$–, and methylamino- denotes $CH_3$–NH–, one hydrogen atom of the substituent $NH_2$– having been replaced by the secondary substituent methyl group.

This relatively simple system is complicated in various ways by old-established custom and by special devices for complex and particular cases.

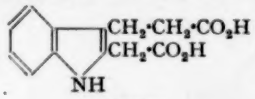
One obvious particular case is the prefix hydro, which denotes addition of a hydrogen atom; replacement here would be meaningless.

Many of the older customs are derived from the binary nomenclature of inorganic chemistry, *e.g.*, -ic acid, ethyl acetate; others are old methods of clarifying an over-simple name, *e.g.*, ether ⟶ ethyl ether ⟶ diethyl ether and ethyl methyl ether; some have specialised origin, *e.g.*, amines, where a radical name has an invented (or semi-invented) amine ending, as in butylamine, diethylamine. (The alkoxy prefix is, however, derived on classical lines: oxy was the accepted name for a HO-substituent before it was replaced by hydroxy; $CH_3$–O– thus, by classical substitution, became methyloxy, abbreviated to methoxy.)

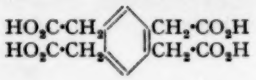
Many deviations from substitutive orthodoxy for complex cases arise from a desire for clarity or to facilitate indexing or both. The compound (XXIII) is termed 2-indolylacetic acid in British nomenclature, but indole-2-acetic acid in American practice so that it can be indexed under the heading Indole. Although in this case it may be argued that indexers should suit their practice to nomenclature rather than dictate nomenclature to suit their convenience,



(XXIII)



(XXIV)



(XXV)

other considerations often arise. Thus, for instance, indole-2-acetic-3β-propionic acid conveys structure (XXIV) to a chemist more clearly than does β-(2-carboxymethyl-3-indolyl)propionic acid; and for (XXV) benzene-1 : 2 : 4 : 5-tetra-acetic acid is more " pictorial " than 1 : 2 : 4 : 5-tetrakiscarboxymethylbenzene.

The significant feature of these " deviating " names is that each part—indole, benzene, acetic acid, propionic acid—denotes a substance in itself, and in juxtaposing them (with inserted positional numerals) there is no indication of the replacement of hydrogen atoms. Such nomenclature is one type of " additive " nomenclature—two substance names are simply added together. It is not used in British nomenclature for simple cases such as (XXIII), but is permitted for complex cases where it greatly improves clarity.

A second type of additive nomenclature is less general and has less justification, namely, juxtaposition of two radical names, again without attention to the fact that according to classical principles juxtaposition implies loss of hydrogen. This occurs in the use of certain prefixes for bivalent groups. It does not occur when bivalent groups are substituted into the same parent compound; thus, in names such as epoxy*cyclo*hexane, 2-oxo*cyclo*hexanecarboxylic acid, or imino*cyclo*pentadiene, the prefixes epoxy, imino, and oxo denote replacement of 2H by –O–, =NH, and =O respectively. However, I.U.C. rule 25 (p 5068) specifies that $CH_3$–$SO_2$–, when attached to carbon, shall be named methylsulphonyl; sulphonyl is considered as the prefix for the bivalent radical –$SO_2$– (p. 5085) and this is juxtaposed to the radical name methyl; no hydrogen is replaced in this process. *Per contra*, according to rule 58.2 (p. 5074) benzenesulphonic acid is derived by the classical process of replacing a hydrogen atom in the parent substance by means of a suffix. Again, there has been variation in the naming of azo-compounds: Ph·N:N·$C_{10}H_6$·OH has been termed benzeneazonaphthol and phenylazonaphthol; I.U.P.A.C. (p. 5098) has now laid down phenylazo as a prefix, whereby the two radicals phenyl and azo (–N:N–) are juxtaposed, without loss of hydrogen. Similarly, I.U.P.A.C. has laid down (p. 5087) that the prefix denoting –CO–OMe shall be methoxycarbonyl (and similarly for analogues), the two radical names methoxy and carbonyl (–CO–) again being additively juxtaposed without loss of hydrogen.

These three I.U.P.A.C. rulings have been accepted by the Chemical Society. The alkoxycarbonyl nomenclature in particular has considerable practical advantage (see footnote 12, p. 5087) and it has proved impossible to devise a generally acceptable alternative. Acceptance of additive radical names recommended for specific usages by I.U.P.A.C. does not, however,

imply that the Society admits the general validity of additive nomenclature for organic chemistry. Additive nomenclature, whether applied to names of parent compounds or of radicals, is accepted when clarity demands it but is regarded as the exception rather than the rule.

*Typographical and Symbolism.*—When abbreviations p and e are used for polar and equatorial (in the steric sense) they should be in roman type (*i.e.*, not underlined in MS), so as to avoid confusion of p = polar with *p* = *para* (cf. p-substituent, *para*-substituent). When the word polar is used in the steric sense in the text, care must be taken to avoid possible confusion with the electrochemical meaning.

Use of the abbreviations *o*, *m*, and *p* should be confined to cases when they are part of a chemical name, as, *e.g.*, in *o*-chlorotoluene, toluene-*p*-sulphonic acid, *m*-nitro-group. In other cases *ortho*, *meta*, and *para* should be written in full, *e.g.*, *ortho*-effect, *ortho*-substituent, *para*-group, *meta*-directing.

A specialised symbolism has been developed for discussion of molecular-rotation differences (*J.*, 1952, 2917).

*Infra-red Spectra.*—The methods to be used in plotting infra-red spectra are recorded in *Proceedings* for Dec., 1952 (p. 164), where also are given conditions governing their acceptance for publication. These decisions were taken as a result of recommendations of a Committee on which other publishing Societies and interested Bodies were represented. (Conditions regarding ultra-violet spectra are at present being considered by a Sub-Committee of the Chemical Society.) Details of a library scheme for deposition of infra-red spectra with the Society and for photo-copies thereof may be obtained from the General Secretary, the Chemical Society.

"*Notices to Authors.*"—A brochure entitled "The presentation of papers for the *Journal of the Chemical Society*" has been prepared, giving information for authors. Each Fellow of the Society is entitled to one copy, gratis, on application to the General Secretary, and further copies at the public price, which is 1*s.* 6*d.* per copy (post free) or 12*s.* 6*d.* per 10 copies (post free).

APPENDIX 1

## *Organic Nomenclature. I.U.P.A.C. Rules.*

CURRENT nomenclature for organic chemistry is based fundamentally on the Definitive Report of the Committee for the Reform of Nomenclature in Organic Chemistry, published in *Comptes rendus* of the 10th Conference (Liége) of the International Union of Chemistry (I.U.C.), 1930, p. 57. The Definitive Report contains 68 rules; details of two of these (rules 34 and 49) were left for consideration later, and the details were published in *Comptes rendus* of the 12th Conference (Lucerne and Zurich), I.U.C., 1936, p. 40.

Although these rules are largely adopted in Gt. Britain and U.S.A., experience has shown the need for revision and expansion. Under the present constitution of the International Union of Pure and Applied Chemistry (I.U.P.A.C.; this is the revised title of I.U.C.), rules must be published as tentative in *Comptes rendus* of a Conference and amended or confirmed at a later meeting in the light of any comments received; thereafter the rules become definitive. Complete revision of the Definitive Report will take some years, but at the 1949 Conference rules 54—62 were revised and a new rule 70 added, and these were confirmed after some amendment at the 1951 Conference (see *Comptes rendus* of the 15th Conference, I.U.P.A.C., 1949, p. 127, and of the 16th Conference, 1951, p. 100).

It is hoped to publish in the Editorial Nomenclature Reports those I.U.P.A.C. rules which become definitive (tentative rules will not be published). Below are given all the definitive organic rules, *i.e.*, the whole Definitive Report as amended in part by the 1949—1951 rules.

The official text of the Definitive Report (including rules 34 and 49) is in French. The English version below is that of A. M. Patterson (*J. Amer. Chem. Soc.*, 1933, **55**, 3905) (a rendering which corresponds less closely to the official French text and leads occasionally to different interpretations was published in *J.*, 1931, 1607). The 1949—1951 rules (nos. 54—62 and 70) were published in English in the *Comptes rendus*. In the text below, British conventions of italicising, punctuation, position of numerical prefixes, and spelling have been substituted throughout as appropriate.

To the rules below are appended comments and explanations by the Editor; these are either enclosed in square brackets and signed, or are printed as footnotes. Numerous comments on the rules have been published previously, notably by A. D. Mitchell ("British Chemical Nomenclature," Ed. Arnold & Co., London, 1948), A. M. Patterson (*loc. cit.*), and Clarence Smith (*J.*, 1936, 1067), and in *Chem. Abs.*, 1945, **39**, 5875, to whom the Editor gratefully acknowledges his debt. The comments below are not intended to duplicate these earlier discussions; they are an attempt to indicate some places where revision of the 1930 rules is implied by the 1949—1951 version of other rules, to point out where British practice still diverges from the international rules, and to draw attention to some novel aspects of the new rules and also to some aspects of the old rules which often appear to be inadequately appreciated by British chemists.

The new I.U.P.A.C. rules include "Extended Examples." These show how the rules can be applied in varied circumstances but they do no more than illustrate the particular rule in question; for instance, the extended examples of radical names show how to form names of radicals from names of substances if the latter are accepted, but they do not lay down that the particular names for the substances are definitively adopted by I.U.P.A.C.

The new rules include also a Formula Index to the radical names; this is not reprinted below.

The *Comptes rendus* of the 15th Conference gave a rule on "Extra Hydrogen"; a much revised version, under the title "Indicated Hydrogen," was published in the *Comptes rendus* of the 16th Conference, and was there stated to be definitive. There appears however to be some doubt about the status of this rule and it is therefore not reprinted below.

I.U.C. rule 34, dealing with organic derivatives of phosphorus, arsenic, and antimony, is not printed below. Current British usage is set out in the Anglo-American agreed rules on p. 5122.

In view of the decision of Council of the Chemical Society (*Proc.*, 1951, 22; *J.*, 1951, 3521), the new I.U.P.A.C. rules will be applied forthwith in the Society's publications; the Editor's comments draw attention to the most notable of the changes involved. However, Council's decision is not held to apply to those few of the old (1930) rules which have not hitherto been observed by the Society, because these are subject to revision by I.U.P.A.C. in the near future.

## I. General

**Rule 1** As few changes as possible will be made in terminology universally adopted.

**Rule 2** For the present, only the nomenclature of compounds of known constitution will be dealt with; the question of substances of imperfectly known constitution is postponed.

**Rule 3** The precise form of words, endings, etc., prescribed in the rules should be adapted to the genius of each language by the sub-committees.

[No such sub-committees exist. Ed.]

## II. Hydrocarbons

**Rule 4** The ending *ane* is adopted for saturated hydrocarbons. Open-chain hydrocarbons will have the generic name *alkanes*.

[This rule does not specify that the ending *ane* is reserved solely for hydrocarbons (contrast *ol* in rule 14, and *ine* in rule 33). Nevertheless such reservation is practised by the Chemical Society, though not by the American Chemical Society; *e.g.*, dioxan in Gt. Britain, dioxane in U.S.A. Similar customs hold for unsaturated compounds; *e.g.*, thiophen, xanthen, in Gt. Britain, but thiophene, xanthene, in U.S.A. Contrariwise, British usage retains the old urethane, which has been changed to urethan in U.S.A. Ed.]

**Rule 5** The present names of the first four normal saturated hydrocarbons (methane, ethane, propane, butane) are retained. Names derived from the Greek or Latin numerals will be used for those having more than four atoms of carbon.

[This rule must now be interpreted in the light of the more recent rule 54.1 and the extended examples thereto; it will be there seen that Greek numeral roots are used, but that 9 (alone or in any of its combinations) is rendered by the Latin nona, and that *n*-$C_{11}H_{24}$ is undecane. Ed.]

**Rule 6** Branched-chain hydrocarbons are regarded as derivatives of the normal hydrocarbons; their names will be referred to the longest normal chain present in the formula by adding to it the designations of the side chains. In case of ambiguity, or if a simpler name would result, that chain which admits of the maximum of substitutions will be selected as the fundamental chain.

[In view of admission of *iso*butyl, *iso*pentyl, *neo*pentyl, and *iso*hexyl as radical names (rule 54.2 and extended examples thereto), the names *iso*butane, *iso*pentane, *neo*pentane, and *iso*hexane must now be " preferred to the systematic names," but use of the prefix *iso* was deliberately restricted by the Commission to the $C_3$—$C_6$ radicals. See also the note to rule 54.2.

[The extended examples to rule 54.2 make clear that *iso*alkyl nomenclature is applied to unsubstituted radicals. Clearly this should apply also to the hydrocarbons *iso*butane, *iso*pentane, and *iso*hexane. It is believed, however, that in this connexion substitution refers to prefixes and that *iso*alkane names may be modified by suffixes, as in *iso*hexanoic acid, *iso*butan-1-ol, *iso*pentan-2-one, provided that no further substituents are present. By analogy, *iso*propanol becomes permissible for the unsubstituted alcohol.

[The phrases " In case of ambiguity, or if a simpler name would result " are liable to various interpretations, for which Patterson (*loc. cit.*) and Mitchell (*op. cit.*, p. 43) should be consulted. Ed.]

**Rule 7** In case there are several side chains, the order in which such chains are named will correspond to the order of their complexity. The chain having the greatest number of secondary and tertiary atoms will be considered the most complex. The alphabetical order may also be followed in such cases.

[For discussions of ambiguities in this rule see Patterson and Mitchell (*locc. cit.*). In the last sentence of the rule the word " also " should be interpreted as " alternatively." The alphabetical order is used in Chemical Society publications; for details of this see *J.*, 1950, 3699. Ed.]

**Rule 8** In the names of open-chain unsaturated hydrocarbons having one double bond the ending *ane* of the corresponding saturated hydrocarbon will be replaced by the ending *ene*; if there are two double bonds, the ending will be *diene*, etc. These hydrocarbons will bear the generic names *alkenes*, *alkadienes*, *alkatrienes*, etc.

*Examples*: propene, hexene, etc.

[Concerning the terminal " e " see the note to rule 4. Ed.]

**Rule 9** The names of triple-bond hydrocarbons will end in *yne*, *diyne*, etc. They will bear the generic name *alkynes*.

*Examples*: propyne, heptyne, etc.

**Rule 10** If there are both double and triple bonds in the fundamental chain the endings *enyne*, *dienyne*, etc., will be used. The generic names of these hydrocarbons will be *alkenynes*, *alkadienynes*, etc.

[The implications of this rule are discussed by Patterson and Mitchell (*locc. cit.*). Ed.]

**Rule 11** Saturated monocyclic hydrocarbons will take the names of the corresponding open-chain saturated hydrocarbons, preceded by the prefix *cyclo*. They will bear the generic name cyclo*alkanes*.

**Rule 12** When monocyclic hydrocarbons are unsaturated, rules 8—10 will be applied. However, in the case of partially saturated polycyclic aromatic compounds the prefix *hydro*, preceded by *di-*, *tetra-*, etc., will be used.

*Example*: dihydroanthracene.

**Rule 13** Aromatic hydrocarbons will be denoted by the ending *ene* and will otherwise retain their customary names. However, the name *phene* may be used instead of *benzene*.

[" Phene " is not used in Chemical Society publications. Ed.]

### III. Fundamental Heterocyclic Compounds

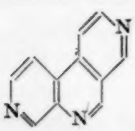
**Rule 14** The endings of customary names, endings which do not correspond to the function of the substance, will undergo the following modifications, so far as they are in accord with the genius of each language: (*a*) The ending *ol* will be changed to *ole*. *Example*: pyrrole. (*b*) The ending *ane* will be changed to *an*. *Example*: pyran.

[The change (*b*) does not decide the question raised in the note to rule 4, for it may be argued that pyrane is not permitted either because it is not a hydrocarbon or because it is unsaturated. Ed.]

**Rule 15** When nitrogenous heterocycles not having the ending *ine* give basic compounds on progressive hydrogenation, such derivation will be indicated by the successive endings *ine*, *idine*.

*Examples*: pyrrole, pyrroline, pyrrolidine; oxazole, oxazoline.

**Rule 16** The ending *a* is adopted for hetero-atoms occurring in a ring. Oxygen will accordingly be indicated by *oxa*, sulphur by *thia*, nitrogen by *aza*, etc. The letter *a* may be elided before a vowel.




*Examples*: thiadiazole, oxadiazole, thiazine, oxazine.

While the universally accepted names of heterocyclic compounds are retained, the names of other heterocyclic compounds are derived from that of the corresponding homocyclic compounds by adding to it the names of the hetero-atoms ending in *a*.

*Example*: 2 : 7 : 9-triazaphenanthrene.

[The first paragraph is incomplete in that use of the endings " ole " and " ine " is not explained in the rules. The principle is however well-known; its extension to other than five-membered rings, as in the Ring Index, has been common in Chemical Society practice.

[It should be noted that use as in the second paragraph of the rule demands reference to the homocyclic compound as parent (cf. *J.*, 1950, 3704, last paragraph). Ed.]

## IV. Simple Functions

**Rule 17** Substances of simple function are defined as those containing a function of one kind only, which may be repeated several times in the same molecule.

[The term " function " itself is not defined, nor do the rules give a comprehensive list of functional groups. The usual interpretation is in the sense of a group conferring characteristic properties on a compound. Thus, OH, $CO_2H$, $NH_2$, are clearly functions (or functional groups), methyl and phenyl are not. The important rules 18 and 64 are normally and best interpreted as if the word " function " meant " a group which can be expressed as a suffix," but this is not implied elsewhere—for instance, rule 19, concerned with halogen derivatives named by prefixes, is included in section IV headed " Simple Functions," and the list of functions in rule 52 certainly excludes such a limitation for general use. Ed.]

**Rule 18** Where there is only one functional group, the fundamental chain will be selected so as to contain this group. When there are several functional groups the fundamental chain will be selected so as to contain the maximum number of these groups.

[This rule is applied only when the function can be expressed as a suffix, *e.g.*, not for halogeno- or nitro-compounds. It is lucidly discussed by Patterson (*loc. cit.*). Ed.]

**Rule 19** Halogen derivatives will be designated by the name of the hydrocarbon from which they are derived, preceded by a prefix indicating the nature and number of the halogen atoms.

[The halide nomenclature, *e.g.*, butyl chloride, pentamethylene dibromide, is nevertheless widely used and is accepted in Chemical Society publications, particularly for simple compounds. As Patterson remarks, rule 1 may be held to cover such long-established names as these and benzotrichloride. Ed.]

**Rule 20** Alcohols and phenols will be given the name of the hydrocarbon from which they are derived, followed by the suffix *ol*. In accordance with rule 1 names universally adopted will be retained, as : phenol, cresol, naphthol, etc.

This nomenclature may also be applied to heterocycles. *Example* : quinolinol.

[Application of this rule to heterocyclic compounds is not favoured in Chemical Society publications, mainly because of the fact that, *e.g.*, quinolinol and quinolone are not related to each other as alcohol and ketone. For the purpose of this and similar rules, *e.g.*, ketones and aldehydes, the terminal " e " is elided before a vowel, but not before a consonant; interposition of numerals has no effect; *e.g.*, hexan-2-ol, hexan-2-one, hexane-2 : 3-diol. Ed.]

**Rule 21** In naming polyhydric alcohols or phenols, one of the forms, *di*, *tri*, *tetra*, etc., will be inserted between the name of the parent hydrocarbon and the suffix *ol*.

**Rule 22** The name mercaptan as a suffix is abandoned; this function will be denoted by the suffix *thiol*.

[As with other suffixes, *thiol* is added to the name of the hydrocarbon, not of the radical. *E.g.*, ethanethiol, not ethylthiol. Ed.]

**Rule 23** Ethers are considered as hydrocarbons in which one or several hydrogen atoms are replaced by alkoxy-groups. However, for symmetrical ethers the present nomenclature may be retained. *Examples* : $CH_3{\cdot}O{\cdot}C_2H_5$ methoxyethane; $CH_3{\cdot}O{\cdot}CH_3$ methoxymethane or methyl ether.

[Nevertheless, " the present nomenclature " is still often used for unsymmetrical ethers in Chemical Society publications, particularly in simple cases, *e.g.*, ethyl methyl ether, methyl naphthyl ether, phenyl propyl ether. Ed.]

**Rule 24** Oxygen linked, in a chain of carbon atoms, to two of these atoms will be denoted by the prefix *epoxy* in all cases where it would be unprofitable to name the substance as a cyclic compound.

*Examples* : ethylene oxide = epoxyethane; epichlorohydrin = 3-chloro-1 : 2-epoxypropane; tetramethylene oxide = 1 : 4-epoxybutane.

[The more usual name for the last example is, of course, tetrahydrofuran. This merely shows the unwisdom of rules containing vague phrases such as " cases where it would be unprofitable to . . ." Ed.]

**Rule 25** Sulphides, disulphides, sulphoxides, and sulphones will be named like the ethers, *oxy* being replaced by *thio*, *dithio*, *sulphinyl*, and *sulphonyl*, respectively.

*Examples*: $CH_3{\cdot}SO_2{\cdot}C_2H_5$ methylsulphonylethane; $CH_3{\cdot}S{\cdot}C_3H_7$ methylthiopropane; $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}SO{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3$ 1-propylsulphinylbutane.

[Nevertheless nomenclature such as ethyl methyl sulphide, methyl propyl sulphone, butyl propyl sulphoxide, diethyl disulphide, is often used in Chemical Society publications. See also footnote 9 (p. 5086). Ed.]

**Rule 26** Aldehydes are characterised by the suffix *al* added to the name of the hydrocarbon from which they are derived; thioaldehydes by the suffix *thial*. Acetals will be named as 1 : 1-dialkoxyalkanes.

[This rule has not found general acceptance for simple cases, which can be regarded as covered by rule 1 (*e.g.*, acetaldehyde, benzaldehyde, glyoxal). Rule 26 can often not be applied when the CHO group is attached directly to a ring, as in 3-formylthiophen (thiophen-3-aldehyde). Also the acetal nomenclature is still widely used and, in some cases, *e.g.*, carbohydrates, the alkoxy-nomenclature cannot be conveniently adopted. Ed.]

**Rule 27** Ketones will receive the ending *one*. Diketones, triketones, thioketones will be designated by the suffixes *dione*, *trione*, *thione*.

**Rule 28** The name *keten* is retained.

[The name is cétène in the French text, ketene in Patterson's translation, but keten in Chemical Society publications—see comment on rule 4. Ed.]

**Rule 29** For acids the rule of the Geneva nomenclature is retained. However, in cases where the use of that nomenclature would not be convenient the carboxyl group will be considered as a substituting group and the name of the acid will be formed by adding to the name of the hydrocarbon the suffix *carbonique* or *carboxylic*, according to the language.

[The Geneva nomenclature was that which led to names such as hexanoic, hexane-1 : 6-dioic, hex-2-enoic acid ($CO_2H = 1$). Rule 29 accords with present British practice as laid down in *J.*, 1950, 3701. That the common trivial names should be considered to be covered by rule 1 is shown by the examples of acid radicals listed in the more recent rule 58.3. The examples for rule 32 are therefore unfortunate as the usual names butyryl chloride and butyramide should clearly be acceptable. The examples for acid radicals (rule 58.3) show that trivial names are accepted up to $C_5$ and, as alternatives, for higher fatty acids, *e.g.*, stearic. Ed.]

**Rule 30** Acids in which an atom of sulphur replaces an atom of oxygen will be named according to the Geneva nomenclature. *Example*: ethane-thioic, -thiolic, -thionic, -thionothiolic. If the carboxyl group is considered as a substituent the compounds will be named *carbothioic* acids. The suffix *carbothiolic* will be used if it is certain that the oxygen of the OH group is replaced by sulphur; the suffix *carbothionic* if it is the oxygen of the CO group; the suffix *carbodithioic* will be used if both atoms are replaced.

**Rule 31** The existing conventions will be retained for salts and esters.

**Rule 32** Acid anhydrides will retain their present mode of designation according to the names of the corresponding acids. For names formed in accordance with the Geneva nomenclature, the amide, amidoximes, amidines, imides, and nitriles will be named like the acids by adding to the name of the corresponding hydrocarbon the endings *amide*, *amidine*, *amidoxime*, *imide*, and *nitrile*, respectively, while the halides will be named by combining chloride, etc., with the name of the radical. *Examples*: $C_3H_7{\cdot}COCl$ butanoyl chloride; $C_3H_7{\cdot}CO{\cdot}NH_2$ butanamide; etc.

If the carboxyl group is considered as a substituent the endings *carbonamide*, *carbonamidine*, *carbonamidoxime*, *carbonimide*, *carbonitrile* will be used. *Examples*: $C_3H_7{\cdot}COCl$ propanecarbonyl chloride; $C_3H_7{\cdot}CO{\cdot}NH_2$ propanecarbonamide; etc.

[Considerable further detail will be required when the rule is revised. For instance, the more recent rule 58.7 restricts the imido-radical termination to cyclic imides, but there is no

instruction how to name non-cyclic imides. However, the extended examples include diacetylamino $(CH_3 \cdot CO)_2N-$, and acetimidoyl $CH_3 \cdot C(:NH)-$, showing that the parent substances should be diacetylamine, and acetimidic acid (cf. *J.*, 1950, 3702 for the last). This practice should be followed in Chemical Society publications, except that the long-established diacetimide and triacetimide will be retained (rule 1).

[Names such as butanonitrile, $C_3H_7 \cdot CN$, have not become established.

[The second paragraph of the rule does not correspond to the Chemical Society's practice, where the terminations given in the rule are replaced, as appropriate, by carboxyamide, carboxyamidine, and carboxyamidoxime. When trivial names for the acids exist, these may be used, *e.g.*, butyramide, butyramidine, and butyramidoxime. There is no British equivalent to "carbonitrile," the substances being called either (i) cyanides (*e.g.*, ethyl cyanide) embodying the name of the alkyl radical, or (ii) nitriles (*e.g.*, propionitrile) derived from the trivial name of the acid. This section of the I.U.C. rule is based solely on the French carbonique, to the exclusion of the English carboxylic, and until it is reconsidered by I.U.P.A.C. in conjunction with the more recent rule 58.1, the Chemical Society's present practice as outlined above will be continued.

[However, British practice for acid halides has been more variable. The ending carbonyl chloride was confirmed by the extended examples to the recent rule 58.1 (p. 5085) which include *cyclo*hexanecarbonyl chloride, and this ending will in future be used in Chemical Society publications for halides of acids named as carboxylic acids. Ed.]

**Rule 33** The ending *ine* is reserved exclusively for nitrogenous bases. The present nomenclature of monoamines is retained. For polyamines, the name of the hydrocarbon will be followed by the suffixes *diamine*, *triamine*, etc.

For aliphatic compounds containing quinquevalent nitrogen the ending *ine* will be changed to *onium*. For cyclic substances containing quinquevalent nitrogen in the ring the ending *ine* will be changed to *inium*; for those with the ending *ole*, this will be changed to *olium*.

*Examples*: pyridine, pyridinium; iminazole, iminazolium.

[Names of the type ethylenediamine, phenylenediamine, etc., rather than ethanediamine, benzenediamine, etc., are however, still current usage for simple cases. Ed.]

**Rule 34** [I.U.C. names for organic derivatives of phosphorus, arsenic, and antimony are superseded for Chemical Society usage by the recent American–British agreement (see p. 5122). Ed.]

**Rule 35** Compounds derived from hydroxylamine by replacement of the hydrogen of the hydroxyl group will be regarded as alkoxy-derivatives; those in which an atom of hydrogen of the $NH_2$ group is replaced, as alkylhydroxylamines. Oximes will be named by adding the suffix *oxime* to the name of the corresponding aldehyde, ketone, or quinone.

*Examples*: $C_2H_5O \cdot NH_2$ ethoxyamine; $C_2H_5 \cdot NH \cdot OH$ ethylhydroxylamine.

[A space is left before the word *oxime*. Ed.]

**Rule 36** The generic term *urea* is retained; it will be used as a suffix for the alkyl and acyl derivatives of urea.

*Examples*: butylurea $C_4H_9 \cdot NH \cdot CO \cdot NH_2$; butyrylurea $C_3H_7 \cdot CO \cdot NH \cdot CO \cdot NH_2$.
The bivalent radical $-NH \cdot CO \cdot NH-$ will be termed ureylene.

**Rule 37** The generic name guanidine is retained.

**Rule 38** The name carbylamine is retained.

[As *iso*cyano is included in the list of radicals issued with the more recent rules, the term *iso*cyanide can now hardly be considered out of order (cf. also rule 39). Ed.]

**Rule 39** *iso*Cyanic and *iso*thiocyanic esters (R·NCO, R·NCS) will be named iso*cyanates* and iso*thiocyanates*.

**Rule 40** The name *cyanate* is reserved for the true esters which on hydrolysis yield cyanic acid or its hydration products. The name *sulphocyanate* will be replaced by *thiocyanate*.

**Rule 41** Nitro-derivatives: no change in present nomenclature.

**Rule 42** Azo-derivatives: the forms *azo*, *azoxy* are retained.

**Rule 43** (*a*) Diazonium compounds, $R\cdot\overset{\overset{+}{\|}}{N}\}X^-$, are named by addition of the suffix *diazonium* to the name of the parent substance (benzenediazonium chloride).

(*b*) Compounds having the same empirical formula but containing tervalent nitrogen will be named by replacing *diazonium* with *diazo* (benzenediazohydroxide).

[The name phenylazo for the radical $Ph\cdot N{:}N-$ will be noted in extended examples (p. 5098). Ed.]

(*c*) Substances of the type $R\cdot N_2\cdot OM$ will be named *diazoates*.

(*d*) Compounds in which the two nitrogen atoms are united to a single carbon atom will be designated by the prefix *diazo* (diazomethane, diazoacetic acid).

(*e*) The term *diazoamino* is retained; however, these compounds may also be regarded as derivatives of triazen.

(*f*) Derivatives of the substances $H_2N\cdot NH\cdot NH\cdot NH_2$, $HN{:}N\cdot NH\cdot NH_2$, $HN{:}N\cdot NH\cdot N{:}NH$ will be named *tetrazans*, *tetrazens*, *pentazdiens*, etc.

**Rule 44** Hydrazines are designated by the name of the alkyl radicals from which they are derived, followed by the suffix *hydrazine*. In cases where the amino-group of amides is replaced by the hydrazino-group, the suffix *hydrazide* will be used. Hydrazo-derivatives are regarded as derivatives of hydrazine.

*Examples*: $CH_3\cdot NH\cdot NH_2$ methylhydrazine; $C_2H_5\cdot NH\cdot NH\cdot C_3H_7$ 1-ethyl-2-propylhydrazine; $C_3H_7\cdot CO\cdot NH\cdot NH_2$ butyrohydrazide or propanecarbohydrazide.

[However, compare note to rule **32**. Ed.]

**Rule 45** Hydrazones and semicarbazones are named like the oximes. The term *osazone* is retained.

**Rule 46** The name *quinone* is retained.

[This is used as a suffix, to be added to the name of the hydrocarbon, except for the trivial names benzoquinone, naphthaquinone, anthraquinone, and phenanthraquinone. Ed.]

**Rule 47** Sulphonic and sulphinic acids will be designated by adding the suffixes *sulphonic* and *sulphinic* to the name of the hydrocarbon.

The analogous acids of selenium and tellurium will bear the names *alkane-selenonic* and *-seleninic* acids; *alkane-telluronic* and *-tellurinic* acids.

[See footnote 9 (p. 5086). Ed.]

**Rule 48** Organometallic compounds will be designated by the names of the organic radicals united to the metal which they contain, followed by the name of the metal.

*Examples*: dimethylzinc, tetraethyl-lead, methylmagnesium chloride.

However, if the metal is united in a complex manner it may be considered as a substituent.

*Example*: $ClHg\cdot C_6H_4\cdot CO_2H$ chloromercuribenzoic acid.

**Rule 49** (*a*, I) Cyclic hydrocarbons with aliphatic side-chains are to be named according to one of the two following methods: (α) The radical names denoting the side-chain are prefixed to the name of the cyclic hydrocarbon. (β) The cyclic hydrocarbon residue, if it can be named as a radical, is considered a substituent of the aliphatic chain.

Naming according to (α) is in general preferable when the side-chain is short or when several side-chains are present. Naming according to (β) is more convenient when the side-chain is long, and particularly when the cyclic hydrocarbon residue is not at this end of the chain.

*Examples*: (α) $C_6H_5\cdot C_2H_5$ ethylbenzene; $CH_3\cdot C_6H_4\cdot C_2H_5$ ethylmethylbenzene; $C_{10}H_7\cdot CH{:}CH_2$ vinylnaphthalene.

(β) $CH_3\cdot CH(C_6H_5)\cdot[CH_2]_5\cdot CH_3$ 2-phenyloctane;
*p*-$(CH_3)_2CH\cdot C_6H_4\cdot CH(CH_3)\cdot CH(CH_3)\cdot[CH_2]_3\cdot CH_3$ 3-methyl-2-*p*-*iso*propylphenylheptane.

For naming cyclic hydrocarbons with side-chains according to (α), it is advisable in many cases to use the common names of simple aromatic hydrocarbons.

*Examples*: *o*-$CH_3 \cdot C_6H_4 \cdot C_2H_5$ *o*-ethyltoluene; 1 : 3 : 2-$(CH_3)_2C_6H_3 \cdot CH{:}CH_2$ 2-vinyl-*m*-xylene; 1 : 2 : 4-$CH_3 \cdot C_6H_3(C_2H_5) \cdot CH(CH_3)_2$ 2-ethyl-*p*-cymene.

(*a*, II) When several cyclic hydrocarbon residues are united by an aliphatic chain the name of the compound will be derived from that of the aliphatic hydrocarbon, provided radical names are available for the cyclic hydrocarbon residue.

*Examples*: $C_6H_5 \cdot CH_2 \cdot C_6H_5$ diphenylmethane; $C_6H_5 \cdot CH_2 \cdot CH(C_6H_5) \cdot [CH_2]_2 \cdot CH_3$ 1 : 2-diphenylpentane.

If this is not the case, or if the possibility of using a convenient radical name makes it desirable, the name of the compound will be derived from that of one of the cyclic hydrocarbons, on the principle of substitution.

*Examples*: 2-$C_{11}H_9 \cdot CH_2 \cdot C_6H_5$ 2-benzylanthracene (better than phenyl-2-anthrylmethane); $C_{10}H_9 \cdot CH_2 \cdot CH_2 \cdot C_6H_5$ 1-2′-phenethylpyrene.

(*b*) When the cyclic hydrocarbons treated of in rule 49*a* carry functions which can be expressed only by a prefix, the same possibilities for names exist as those indicated in rule 49*a*.

*Examples*: $C_6H_5 \cdot CHCl \cdot CH_2Cl$ 1 : 2-dichloro-1-phenylethane or 1′ : 2′-dichloroethylbenzene; $C_6H_5 \cdot CH_2 \cdot CH(CH_3) \cdot CH_2Cl$ 1-chloro-2-methyl-3-phenylpropane; *p*-$Cl \cdot C_6H_4 \cdot CH_2 \cdot CH_2Cl$ *p*-chloro-(2′-chloroethyl)benzene or 1-chloro-2-*p*-chlorophenylethane.

For naming derivatives of monocyclic hydrocarbons which have common names, it will be of advantage to employ these names.

*Examples*: *p*-$Cl \cdot C_6H_4 \cdot CH_3$ *p*-chlorotoluene (1-chloro-4-methylbenzene); *p*-$Cl \cdot C_6H_4 \cdot CH_2Cl$ 4 : ω-dichlorotoluene (1-chloro-4-chloromethylbenzene, 4-chlorobenzyl chloride); 1 : 2 : 4-$CH_3 \cdot C_6H_4(NO_2) \cdot CH(CH_3)_2$ 2-nitro-*p*-cymene (1-methyl-2-nitro-4-*iso*propylbenzene).

[The original text of this rule has been amended, above, as required by the more recent rules and in the light of the Society's customs. Of the many gaps in this rule, perhaps the most obvious is the absence of the generally accepted principle that a smaller radical is considered as a substituent into a larger unit. Ed.]

**Rule 50** If it is necessary to avoid ambiguity, the names of complex radicals will be placed in parentheses. Examples: (dimethylphenyl)amine = $(CH_3)_2C_6H_3 \cdot NH_2$; dimethylphenylamine = $C_6H_5 \cdot N(CH_3)_2$.

[The intention of the rule is clear, although the examples are unfortunate because the extended examples published more recently include the radicals xylidino and anilino so that the names become xylidine and dimethylaniline. Current customs of the Society, as set out in *J.*, 1950, 3705, may be considered as amplification of the rule. Ed.]

## V. Complex Functions

**Rule 51** For compounds of complex function, that is to say, for compounds possessing different functions, only one kind of function (the principal function) will be expressed by the ending of the name. The other functions will be designated by appropriate prefixes.

[The need for this rule is evident when it is taken in conjunction with rule 64 which prescribes priority for the lowest number to the suffix. If there were two suffixes, as for instance, pentanolone for $CH_3 \cdot CH(OH) \cdot CH_2 \cdot CO \cdot CH_3$, the numbering would not be prescribed by rule 64. (Rule 53 shows that the rule should be applied even when no ambiguity of numbering arises, *e.g.*, for heterocycles, steroids, triterpenes, etc.) However, rule 51 is incomplete as it does not state which of two or more different functions is to be named as a suffix, *e.g.*, whether the above substance is to be a hydroxypentanone or an oxopentanol. After a study of general practice, *Chemical Abstracts* (1945, **39**, 5876, para. 68) prescribed the following order of precedence for citation as suffix and therefore for lowest available number: 'onium compounds, acid (carboxylic, arsonic, sulphonic, stibonic, others), acid halide, amide, imide, amidine, aldehyde, nitrile, *iso*cyanide, ketone, alcohol, phenol, thiol, amine, imine, ether, sulphide (and sulphoxide and sulphone). (The above example is therefore 4-hydroxypentan-2-one.) Although not complete, this list serves for most cases.

These principles should be used in Chemical Society publications unless they obscure the exposition.

[Unsaturated groupings are not considered to be functions for the purpose of rule 51 and 64; indeed, if this were not so, the names alkenyne and alkadienyne of rule 10 would be incorrect. Thus names such as pent-3-en-2-ol are in order.

[Rule 51 is extended in practice in the sense that if a substance contains a function which can be expressed as a suffix then it shall be so expressed; *e.g.*, pentan-2-one, not 2-oxopentane; thiophen-3-carboxylic acid, not 3-carboxythiophen. This is, at the least, in line with Rule 18. Ed.]

**Rule 52** The following prefixes and suffixes will be used for designating the functions.

| Function | Prefix | Suffix |
|---|---|---|
| Acid and derivatives | carboxy | carboxylic, carbonyl, carbonamide, etc., or oic, oyl, etc. |
| Alcohol | hydroxy | ol |
| Aldehyde | oxo | al |
| | aldo, in generic sense, or formyl, for CHO | |
| Amine | amino | amine |
| Azo-derivative | azo | |
| Azoxy-derivative | azoxy | |
| Carbonitrile (nitrile) | cyano | carbonitrile or nitrile |
| Double bond | | ene |
| Ether | alkoxy | |
| Ethylene oxide, etc. | epoxy | |
| Halide | halogeno | |
| Hydrazine | hydrazino | hydrazine |
| Ketone | oxo | one |
| | keto, in generic sense | |
| Mercaptan | mercapto | thiol |
| Nitro-derivative | nitro | |
| Nitroso-derivative | nitroso | |
| Quinquevalent nitrogen | | onium, inium |
| Sulphide | alkylthio | |
| Sulphinic derivative | sulphino | sulphinic |
| Sulphone | sulphonyl | |
| Sulphonic derivative | sulpho | sulphonic |
| Sulphoxide | sulphinyl | |
| Triple bond | | yne |
| Urea | ureido | urea |

[Aldo and keto were " restricted to the generic sense " by the more recent list of radical names. Hitherto, in Chemical Society practice, keto has been used as a prefix. This will now cease and the prefix used for doubly linked oxygen will be oxo. Practical advantages of this are exemplified by the following: (*a*) If, in a *N*-heterocyclic compound, a CO group is adjacent to nitrogen its rôle is that of an amide rather than of a ketone; thus a name such as 1 : 2 : 3 : 4-tetrahydro-2-oxoquinoline is better than 1 : 2 : 3 : 4-tetrahydro-2-ketoquinoline. (*b*) It is very convenient to be able to name a side-chain terminating in an aldehyde group as an oxoalkyl radical, *e.g.*, 2-4′-oxobutylquinoline. Further, a keto-group is CO, *i.e.*, includes the carbon atom; when conversion of $CH_2$ into CO is designated by a prefix, it is more in keeping with the principle of substitutive nomenclature that this should be done by means of oxo, *i.e.*, doubly linked oxygen replacing hydrogen, than by means of keto.

[The change of alkanethiol for the substance (rule 22) into alkylthio for the radical prefix should be noted. Ed.]

**Rule 53** The names of derivatives of fundamental heterocyclic substances will be formed according to the preceding rules.

## VI. Radicals

**Rule 54.1** Univalent radicals derived from saturated aliphatic hydrocarbons (alkanes) will have the generic name *alkyls*. Those derived from normal alkanes by removal of hydrogen from a terminal carbon atom will be named by replacing the ending *ane* of the hydrocarbon by *yl*. The carbon atom with the free valency is numbered as 1. As a class these radicals will be called normal, or straight-chain, *alkyls*.

*Examples*: butyl, pentyl, hexyl, nonyl, undecyl, hexadecyl.

[Amyl is not recognised, and pentyl is to be used in its place. The absence of the *n*-prefix was deliberate. Ed.]

**Rule 54.2** Radicals having the structure $(CH_3)_2CH\cdot[CH_2]_n-$ (where $n$ is 0, 1, 2, or 3) will be named from the isomeric normal alkyls by prefixing *iso*. The generic name of these radicals will be iso*alkyls*.

*Examples*: *iso*propyl $(CH_3)_2CH-$ *iso*butyl $(CH_3)_2CH\cdot CH_2-$

[The recognition accorded in this recent rule and its extended examples (p. 5082) to the *iso*-radicals from *iso*propyl to *iso*hexyl has various repercussions; cf. notes for rule 6. The extended examples make clear that this rule applies only to the unsubstituted radical, though this is not stated in the rule itself. Ed.]

**Rule 54.3** Other univalent radicals derived from alkanes will be named as derivatives of the longest normal alkyl present, in the same way as the corresponding hydrocarbons in rule 6, the carbon atom with the free valency being numbered as 1.

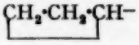
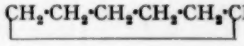
*Examples*: 1-methylpentyl $CH_3\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH(CH_3)-$
2-methylpentyl $CH_3\cdot CH_2\cdot CH_2\cdot CH(CH_3)\cdot CH_2-$

However, the following unambiguous names for the following (unsubstituted) alkyl radicals, sanctioned by usage, are preferred to the systematic names:

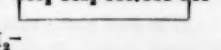
*sec.*-butyl $CH_3\cdot CH_2\cdot CH(CH_3)-$ *tert.*-butyl $(CH_3)_3C-$ *neo*pentyl $(CH_3)_3C\cdot CH_2-$

[Names such as 2-*n*-hexyl for $CH_3\cdot CH_2\cdot CH_2\cdot CH_2\cdot CH(CH_3)-$ are not sanctioned. Ed.]

**Rule 54.4** Univalent radicals derived from *cyclo*alkanes will be named by replacing the ending *ane* of the hydrocarbon name by *yl*, the carbon atom having the free valency being numbered as 1. The generic name of these radicals will be cyclo*alkyls*.

*Examples*: *cyclo*propyl  *cyclo*hexyl 

**Rule 55.1** The names of univalent radicals derived from unsaturated aliphatic or alicyclic hydrocarbons will have the endings *enyl*, *ynyl*, *dienyl*, etc., the positions of the double and triple bonds being indicated where necessary. The carbon atom with the free valency will be numbered as 1, except in those cases where the enumeration has previously been established.

*Examples*: ethynyl $CH{:}C-$ buta-1 : 3-dienyl $CH_2{:}CH\cdot CH{:}CH-$
but-2-enyl $CH_3\cdot CH{:}CH\cdot CH_2-$ *cyclo*pent-2-enyl 

2-methylallyl, preferred to methallyl $CH_2{:}C(CH_3)\cdot CH_2-$

With aliphatic radicals the chain containing a maximum of unsaturated linkages will be taken as the fundamental chain, double bonds being given preference to triple bonds.

*Example*: 1-butylbut-2-enyl $CH_3\cdot CH{:}CH\cdot CH(CH_2\cdot CH_2\cdot CH_2\cdot CH_3)-$

The following names, sanctioned by usage, are preferred to the systematic names:

vinyl to ethenyl $CH_2{:}CH-$ allyl to prop-2-enyl $CH_2{:}CH\cdot CH_2-$
*iso*propenyl (for unsubstituted radical only) to 1-methylvinyl $CH_2{:}C(CH_3)-$

Trivial names of unsubstituted complex radicals of this class such as geranyl, neryl, linalyl, and phytyl are admitted.

[Names specified as "preferred" will be used in Chemical Society publications in this and other cases.

[The rule does not elucidate all the uncertainties inherent in the older rules 8—10. Ed.]

**Rule 56.1** Bivalent and tervalent radicals derived from univalent hydrocarbon radicals whose authorized names end in *yl* by removal (where the structure permits) of one or two hydrogen atoms from the carbon atom having the free valency will be named by adding *idene* or *idyne* respectively to the name of the corresponding univalent radical. The carbon atom having the free valencies will be numbered as 1, except in those cases where the enumeration has previously been established.

The name methylene is retained.

*Examples*: ethylidene $CH_3{\cdot}CH{=}$
ethylidyne $CH_3{\cdot}C{\equiv}$
vinylidene $CH_2{:}C{=}$ (preferred to ethylidene)
*iso*propylidene (for unsubstituted radical only) $(CH_3)_2C{=}$
benzylidene (point of attachment = α) $C_6H_5{\cdot}CH{=}$
benzylidyne $C_6H_5{\cdot}C{\equiv}$

**Rule 56.2** Bivalent or tervalent radicals derived from univalent non-hydrocarbon radicals whose authorized names end in *yl* by removal (where the structure permits) of one or two hydrogen atoms from the carbon atom having the free valency will be named by adding *idene* or *idyne* respectively to the name of the corresponding univalent radical. The carbon atom having the free valencies will be numbered as 1 except in those cases where the enumeration has previously been established.

*Examples*: acetonylidene $CH_3{\cdot}CO{\cdot}CH{=}$ 4-piperidylidene $N\langle^{[CH_2]_2}_{[CH_2]_2}\rangle C{=}$

**Rule 57.1** The names of bivalent radicals derived from normal alkanes by removal of a hydrogen atom from each of the two terminal carbon atoms of the chain will be ethylene, trimethylene, tetramethylene, etc.

The name propylene is retained for the radical $CH_3{\cdot}CH{\cdot}CH_2{-}$.

**Rule 57.2** Bivalent radicals similarly derived from normal alkenes, alkadienes, alkynes, etc., by removing a hydrogen atom from each of the terminal carbon atoms will be named by replacing the endings *ene*, *diene*, *yne*, etc., of the hydocarbon name by *enylene*, *dienylene*, *ynylene*, etc., the positions of the double and triple bonds being indicated where necessary.

The name vinylene as sanctioned by usage is preferred to ethenylene.

*Examples*: propenylene $-CH_2{\cdot}CH{:}CH-$ but-2-enylene $-CH_2{\cdot}CH{:}CH{\cdot}CH_2-$

**Rule 57.3** Bivalent radicals derived from saturated or unsaturated alicyclic hydrocarbons by removing a hydrogen atom from each of two different carbon atoms of the ring will be named by replacing the endings *ane*, *ene*, *diene*, *yne*, etc., of the hydrocarbon name by *ylene*, *enylene*, *dienylene*, *ynylene*, etc., the positions of the double and triple bonds and of points of attachment being indicated. Preference in numbering is given to the points of attachment.

*Examples*: *cyclo*pent-1 : 3-ylene, *cyclo*hex-3-en-1 : 2-ylene, *cyclo*hexa-2 : 5-dien-1 : 4-ylene, *cyclo*hexa-3 : 5-dien-1 : 3-ylene.

[The last name exemplifies the assignment of lowest numbers to the points of attachment without regard to the sum of the numbers. Thus, $3 + 5 + 1 + 3 = 12$, whereas for the possible alternative, *cyclo*hexa-1 : 3-dien-1 : 5-ylene, the sum of the numerals is 10. Ed.]

**Rule 58.1** The systematic names of radicals derived from carboxylic acids by removal of OH from all carboxyl groups will be formed by changing the ending *carboxylic* of the systematic name of the acids to *carbonyl* or, if the Geneva nomenclature is used, the ending *oic* to *oyl*. Where practicable, the latter names are to be preferred.

*Examples*: hexanoyl, preferred to 1-pentanecarbonyl $CH_3{\cdot}[CH_2]_4{\cdot}CO-$
hexanedioyl, preferred to 1 : 4-butanedicarbonyl $-CO{\cdot}[CH_2]_4{\cdot}CO-$

**Rule 58.2** The acid radicals derived from sulphonic and sulphinic acids and the like will be named by changing the ending *ic* of the names of the latter to *yl*.

*Examples*: benzenesulphonyl $C_6H_5{\cdot}SO_2-$ benzenesulphinyl $C_6H_5{\cdot}SO-$

[See footnote 9 (p. 5086). Ed.]

**Rule 58.3** Trivial names of radicals of carboxylic acids derived by removal of OH from all carboxyl groups will be formed from the accepted trivial names of the acids by changing the ending *ic* or *oic* to *oyl* (see also rule 58.5).

*Examples*: stearoyl from stearic acid — piperonyloyl from piperonylic acid
maloyl from malic acid — phthaloyl from phthalic acid
maleoyl from maleic acid
aspartoyl from aspartic acid $-CO\cdot CH_2\cdot CH(NH_2)\cdot CO-$
glutamoyl from glutamic acid $-CO\cdot CH_2\cdot CH_2\cdot CH(NH)_2\cdot CO-$

Exceptions are made, however, for the following radical names in general use, which remain unaltered: formyl, acetyl, propionyl, butyryl, *iso*butyryl, valeryl, *iso*valeryl, oxalyl, malonyl, succinyl, and glutaryl.

[The useful device for differentiating mono- from di-radicals of aspartic and glutamic acid should be noted (cf. extended examples to rule 58.5, p. 5089). Ed.]

**Rule 58.4** The acid radicals of compounds which are named as amic acids (half amides of dibasic acids) will be named with the ending *amoyl*.

*Examples*: oxamoyl from oxamic acid
succinamoyl from succinamic acid
phenylcarbamoyl from phenylcarbamic acid $C_6H_5\cdot NH\cdot CO-$
phenylsulphamoyl from phenylsulphamic acid $C_6H_5\cdot NH\cdot SO_2-$

[Note the change in British nomenclature from phenylcarbamyl to phenylcarbamoyl. The radical $NH_2\cdot CO-$, hitherto termed carbamyl, is now carbamoyl (p. 5089). Similar changes apply for sulphamoyl ($NH_2\cdot SO_2-$) and the like. Ed.]

**Rule 58.5** Radicals derived from amino-acids which have trivial names ending in *ine* by removal of OH from all $-CH(NH_2)\cdot CO_2H$ and related groups will be named by replacing the ending *ine* with *yl*.

*Examples*: glycyl (from glycine), tyrosyl (from tyrosine), cystyl (from cystine).

The following names do not conform to this rule but are recommended: asparaginyl (from asparagine), glutaminyl (from glutamine), cysteinyl (from cysteine), tryptophyl (from tryptophan).

The corresponding radicals derived from aspartic acid and glutamic acid will be called aspartyl and glutamyl.

**Rule 58.6** The names of amide radicals, $R\cdot CO\cdot NH-$, $R\cdot SO_2\cdot NH-$, etc., will be formed from the systematic or trivial names of the corresponding amides by changing the ending *amide* to *amido*.

*Examples*: acetamido, heptanamido, benzenesulphonamido.

**Rule 58.7** The names of radicals derived from cyclic imides by removal of the H attached to imide-nitrogen will be formed from the systematic or trivial imide names by changing the ending *imide* to *imido*.

*Examples*: succinimido $\begin{matrix}CH_2\cdot CO\\ |\\ CH_2\cdot CO\end{matrix}\!\!>\!N-$ phthalimido $o\text{-}C_6H_4\!<\!\begin{matrix}CO\\ CO\end{matrix}\!\!>\!N-$

[This rule confines the imido termination to cyclic compounds. See note to rule 32. Ed.]

**Rule 58.8** Radicals derived from imidic acids by removal of OH from all $C(:NH)\cdot OH$ groups will be formed from the systematic or trivial names of the corresponding imidic acids by changing *imidic acid* to *imidoyl*.

*Examples*: acetimidoyl $CH_3\cdot C(:NH)-$ benzimidoyl $C_6H_5\cdot C(:NH)-$

[This useful nomenclature has already been adopted in the *Journal* (cf. *J.*, 1950, 3702). Ed.]

**Rule 58.9** Radicals having the formula RHN– and RR'N–, derived from bases whose names end in *ine*, will (unless the nitrogen atom is a ring member in which case Rule 60 is applied) be named by changing the ending *ine* to *ino*.

*Examples*: dimethylamino, anilino.

Guanidino, $H_2N{\cdot}C(:NH){\cdot}NH–$, and benzidino, $p\text{-}H_2N{\cdot}C_6H_4{\cdot}C_6H_4{\cdot}NH–$, are names sanctioned by usage for univalent radicals of polyamines.

**Rule 59.1** Univalent radicals derived from aromatic hydrocarbons with names ending in *ene* by removal of a hydrogen atom from an aromatic or alicyclic ring will in principle be named by changing the ending *ene* of the names of the hydrocarbons to *enyl*.

*Examples*: chrysenyl, pyrenyl, indenyl, fluorenyl, acenaphthenyl.

However, the radicals $C_6H_5–$ and $C_6H_5{\cdot}C_6H_4–$ will continue to be named phenyl and diphenylyl. Moreover, certain abbreviations sanctioned by usage are authorized; as, tolyl, naphthyl, anthryl, phenanthryl.

[The I.U.P.A.C. text has biphenylyl, but see note to rule 67. Ed.]

**Rule 60.1** Univalent radicals derived from heterocyclic compounds by removal of hydrogen from a ring will in principle be named by adding *yl* to the names of the parent compounds (with elision of final *e* if present).

*Examples*: indolyl from indole — triazolyl from triazole
pyrrolinyl from pyrroline — triazinyl from triazine

However, certain abbreviations sanctioned by usage and not causing ambiguity are authorized, namely, furyl, pyridyl, piperidyl, quinolyl, and *iso*quinolyl. The radical of thiophen will continue to be named thienyl.

The names piperidino and morpholino are preferred to 1-piperidyl and 4-morpholinyl because of usage.

[The principle that in cyclic compounds the termination *ino* denotes $>N–$ has been used widely and with success in the *Journal*, *e.g.*, pyridino, triazino, pyrrolidino. To conform with the rule this must however now be restricted to piperidino and morpholino, and the other names become, *e.g.*, 1-pyridyl, 1-pyrrolidinyl. Ed.]

**Rule 61.1** Radicals formed by removal of a hydrogen atom from a side chain of a cyclic compound will be regarded as substituted aliphatic radicals.

However, the radicals $C_6H_5{\cdot}CH_2–$, $C_6H_5{\cdot}CH_2{\cdot}CH_2–$, $C_6H_5{\cdot}CH{:}CH–$, $C_6H_5{\cdot}CH{:}CH{\cdot}CH_2–$, $C_4H_3O{\cdot}CH_2–$, and $C_4H_3S{\cdot}CH_2–$ will be named benzyl, phenethyl, styryl, cinnamyl, furfuryl (preferred to 2-furylmethyl), and thenyl, respectively, the point of attachment being indicated by α.

[In accordance with this rule, phenethyl will now be used in Chemical Society publications. Ed.]

**Rule 62.1** Bivalent radicals derived from aromatic compounds by removal of a hydrogen atom from each of two different carbon atoms of the ring are named by changing the ending *yl* of the univalent radical name to *ylene*.

*Examples*: phenylene, naphthylene, anthrylene, phenanthrylene, acenaphthenylene.

**Rule 63** The order in which prefixes or radicals are stated (alphabetical order or conventional order) remains optional.

[The alphabetical order is used in Chemical Society publications; cf. *J.*, 1950, 3699. Ed.]

## VII. Numbering

**Rule 64** In aliphatic compounds the carbon atoms of the fundamental chain will be numbered from one end to the other with the use of arabic numerals. In case of ambiguity the lowest numbers will be given (1) to the principal function, (2) to double bonds, (3) to triple bonds, (4) to atoms or radicals designated by prefixes. The expression " lowest numbers " signifies

those that include the lowest individual number or numbers. Thus 1 : 3 : 5 is lower than 2 : 4 : 6; 1 : 5 : 5 lower than 2 : 6 : 6; 1 : 2 : 5 lower than 1 : 4 : 5; 1 : 1 : 3 : 4 lower than 1 : 2 : 4 : 4.

[The " principal function," for the purpose of this rule, is that which is expressed by a suffix—there can be only one such. In this connection the notes to rules 17 and 51 should be consulted. If there is no suffix, then criteria 2, 3, and 4 should be applied, as necessary, in that order. If still no decision is reached, proceed to rule 66.

[Rule 64 is stated to apply to aliphatic compounds. In absence of further specific rules it is applied to *cyclo*alkanes, *cyclo*alkenes, etc., and, with omission of criterion 2, to aromatic and heterocyclic compounds so far as the fixity of their numbering permits.

[The second part of rule 64 is not comprehensive; this has been discussed by Patterson (*loc. cit.*), Mitchell (*op. cit.*), and others. Ed.]

**Rule 65** Positions in a side chain will be designated by numerals or letters, starting from the point of attachment. The numerals or letters will be in parentheses with the name of the chain.

[For typographical conventions of the Society see *J.*, 1950, 3705. Ed.]

**Rule 66** In case of ambiguity in the numbering of atoms or radicals designated by prefixes, the order will be that chosen for the prefixes before the name of the fundamental compound or side chain of which they are substituents.

[This applies only if a decision is not reached by rule 64 (*q.v.*). It requires, for example, 1 : 3-dichloro-5-ethylbenzene but 1-ethyl-3 : 5-difluorobenzene when the alphabetical order is used. Ed.]

**Rule 67** The prefixes *di*, *tri*, *tetra*, etc., will be used before simple expressions (for example, diethylbutanetriol) and the prefixes *bis*, *tris*, *tetrakis*, etc., before complex expressions.

*Examples*: bismethylaminopropane $CH_3{\cdot}NH{\cdot}[CH_2]_3{\cdot}NH{\cdot}CH_3$; bisdimethylaminoethane $(CH_3)_2N{\cdot}CH_2{\cdot}CH_2{\cdot}N(CH_3)_2$.

The prefix *bi* will be used only to denote the doubling of a radical or compound; for example, biphenyl.

[Di, not bi, is used in Chemical Society nomenclature, where also only radicals are doubled. $C_6H_5{\cdot}C_6H_5$ is diphenyl; $(C_5H_4N)_2$ is di-2-pyridyl, etc. *p*-$CO_2H{\cdot}C_6H_4{\cdot}C_6H_4{\cdot}CO_2H$-*p* is diphenyl-4 : 4′-dicarboxylic acid (doubling of a radical), and not 4 : 4′-dibenzoic acid (doubling of a molecule). This British practice remains current. Ed.]

**Rule 68** A catalogue of cyclic systems, with their numberings according both to the existing system and to that of Mr. Patterson, is in preparation under the auspices of the National Research Council of the United States and of the American Chemical Society.

[This is not really a rule. It refers to " The Ring Index, a List of Ring Systems used in Organic Chemistry," by Patterson and Capell, Reinhold Publ. Corpn., 1940, American Chemical Society Monograph No. 84. This system of nomenclature has been discussed at I.U.C. meetings but has not been officially adopted. It has been widely but not universally used in Chemical Society publications; it is particularly valuable in complex cases. Ed.]

(?**Rule 69**) In order to avoid all confusion the Commission recommends placing a scheme of numbering at the head of each article.

**Rule 70.1** The name of the compound $SiH_4$ will be *silane*. Compounds having the general formula $H_3Si{\cdot}[SiH_2]_n{\cdot}SiH_3$ will be called *disilane*, *trisilane*, etc., according to the number of silicon atoms present. Compounds of the general formula $Si_nH_{2n+2}$ will have the generic name *silanes*.

*Example*: Trisilane $H_3Si{\cdot}SiH_2{\cdot}SiH_3$

**Rule 70.2** Compounds having the formula $H_3Si{\cdot}[NH{\cdot}SiH_2]_n{\cdot}NH{\cdot}SiH_3$ will be called *disilazane*, *trisilazane*, etc., according to the number of silicon atoms present; they will have the generic name *silazanes*.

*Example*: Trisilazane $H_3Si{\cdot}NH{\cdot}SiH_2{\cdot}NH{\cdot}SiH_3$

**Rule 70.3** Compounds having the formula $H_3Si{\cdot}[S{\cdot}SiH_2]_n{\cdot}S{\cdot}SiH_3$ will be called *disilthiane, trisilthiane*, etc., according to the number of silicon atoms present; they will have the generic name *silthianes*.

*Example*: Trisilthiane $H_3Si{\cdot}S{\cdot}SiH_2{\cdot}S{\cdot}SiH_3$

**Rule 70.4** Compounds having the formula $H_3Si{\cdot}[O{\cdot}SiH_2]_n{\cdot}O{\cdot}SiH_3$ will be called *disiloxane, trisiloxane*, etc., according to the number of silicon atoms present; they will have the generic name *siloxanes*.

*Example*: Trisiloxane $H_3Si{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}SiH_3$

**Rule 70.5** For designating the positions of substituents on compounds named as silanes, silazanes, silthianes, and siloxanes, each member of the fundamental chain will be numbered from one terminal silicon atom to the other. When two or more possibilities for numbering occur, the same principles will be followed as for carbon compounds.

*Examples*: 1-Butyl-2 : 3-dichloro-2-pentyltrisilane $Cl{\cdot}SiH_2{\cdot}SiCl(C_5H_{11}){\cdot}SiH_2{\cdot}C_4H_9$
2-Methyl-3-pentyloxytrisilazane $SiH_3{\cdot}N(CH_3){\cdot}SiH(OC_5H_{11}){\cdot}NH{\cdot}SiH_3$
1-Methoxytrisiloxane $CH_3O{\cdot}SiH_2{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}SiH_3$

**Rule 70.6** The following names of radicals containing silicon are adopted; these illustrate the principles on which any further radical names should be formed.

| | | | |
|---|---|---|---|
| silyl | $H_3Si-$ | siloxy | $H_3Si{\cdot}O-$ |
| silylene | $H_2Si=$ | silylthio | $H_3Si{\cdot}S-$ |
| silylidyne | $HSi\equiv$ | silylamino | $H_3Si{\cdot}NH-$ |
| disilanyl | $H_3Si{\cdot}SiH_2-$ | disilanoxy | $H_3Si{\cdot}SiH_2{\cdot}O-$ |
| trisilanyl | $H_3Si{\cdot}SiH_2{\cdot}SiH_2-$ | disilanylthio | $H_3Si{\cdot}SiH_2{\cdot}S-$ |
| disilanylene | $-SiH_2{\cdot}SiH_2-$ | disilanylamino | $H_3Si{\cdot}SiH_2{\cdot}NH-$ |
| trisilanylene | $-SiH_2{\cdot}SiH_2{\cdot}SiH_2-$ | disiloxanoxy | $H_3Si{\cdot}O{\cdot}SiH_2{\cdot}O-$ |
| *cyclo*hexasilanyl | $SiH_2{\cdot}SiH_2{\cdot}SiH-$ (with $SiH_2{\cdot}SiH_2{\cdot}SiH_2$) | disiloxanylthio | $H_3Si{\cdot}O{\cdot}SiH_2{\cdot}S-$ |
| | | disiloxanylamino | $H_3Si{\cdot}O{\cdot}SiH_2{\cdot}NH-$ |
| disiloxanyl | $H_3Si{\cdot}O{\cdot}SiH_2-$ | disilthianoxy | $H_3Si{\cdot}S{\cdot}SiH_2{\cdot}O-$ |
| disilthianyl | $H_3Si{\cdot}S{\cdot}SiH_2-$ | disilthianylthio | $H_3Si{\cdot}S{\cdot}SiH_2{\cdot}S-$ |
| disilazanyl | $H_3Si{\cdot}NH{\cdot}SiH_2-$ | disilazanoxy | $H_3Si{\cdot}NH{\cdot}SiH_2{\cdot}O-$ |
| | | disilazanylamino | $H_3Si{\cdot}NH{\cdot}SiH_2{\cdot}NH-$ |

Compound radical names may be formed in the usual manner.

| | | |
|---|---|---|
| *Examples*: | Silyldisilanyl | $(H_3Si)_2SiH-$ |
| | Disilyldisilanyl | $(H_3Si)_3Si-$ |
| | Triphenylsilyl | $(C_6H_5)_3Si-$ |

[In compound radical names the *yl* is elided before *oxy*, but not before amino, etc. This follows custom for methoxy to butoxy, but the correct names from pentyloxy onwards retain the *yl* (cf. footnote 42, p. 5097). Ed.]

**Rule 70.7** Open-chain compounds which have the requirements for more than one of the structures as defined in rules 70.1—4, will be named, if possible, in terms of the *silane, silazane, silthiane*, or *siloxane* containing the largest number of silicon atoms.

*Examples*: 3-Siloxytrisilthiane $H_3Si{\cdot}S{\cdot}SiH(O{\cdot}SiH_3){\cdot}S{\cdot}SiH_3$

1-Siloxy-3-(disilthianoxy)trisilthiane $H_3Si{\cdot}S{\cdot}SiH(O{\cdot}SiH_2{\cdot}S{\cdot}SiH_3){\cdot}S{\cdot}SiH_2{\cdot}O{\cdot}SiH_3$

[The second example depends on the fact that all the units ·Si·X· in the fundamental chain must be the same; the chain in this example containing the largest total number of silicon atoms is Si·O·S·S·Si·O·Si·S·Si, but the mixed Si·S·Si·O chain does not afford a basis admissible for the prescribed nomenclature. Ed.]

**Rule 70.8** When there is a choice between two parent compounds possessing the same number of silicon atoms, the order of precedence shall be *siloxanes*, *silthianes*, *silazanes*, and *silanes*.

*Examples*: 1-Silylthiodisiloxane $SiH_3{\cdot}O{\cdot}SiH_2{\cdot}S{\cdot}SiH_3$
1-Silylaminodisilthiane $SiH_3{\cdot}S{\cdot}SiH_2{\cdot}NH{\cdot}SiH_3$
1-Phenyl-3-silyldisiloxane $SiH_3{\cdot}SiH_2{\cdot}O{\cdot}SiH_2{\cdot}C_6H_5$

[The numbering in the third example is based on rule 66 plus the alphabetical order of prefixes (rule 63). The disiloxane chain could have been numbered

$$SiH_3{-}\overset{3}{S}iH_2{\cdot}\overset{2}{O}{\cdot}\overset{1}{S}iH_2{-}C_6H_5 \quad \text{or} \quad SiH_2{-}\overset{1}{S}iH_2{\cdot}\overset{2}{O}{\cdot}\overset{3}{S}iH_2{-}C_6H_5$$

In the version printed, the former was used because the prefix phenyl precedes silyl alphabetically. Ed.]

**Rule 70.9** Cyclic silicon compounds having the formula $[SiH_2]_n$ will be called cyclo*trisilane*, cyclo*tetrasilane*, etc., according to the number of members in the ring; they will have the generic name cyclo*silanes*.

*Example*: *cyclo*Trisilane $SiH_2{\cdot}SiH_2{\cdot}SiH_2$

**Rule 70.10** Cyclic compounds having the formula $[SiH_2{\cdot}NH]_n$ will be called cyclo*disilazane*, cyclo*trisilazane*, etc., according to the number of silicon atoms in the ring. They will have the generic name cyclo*silazanes*.

*Example*: *cyclo*Trisilazane $HN{\cdot}SiH_2{\cdot}NH{\cdot}SiH_2{\cdot}NH{\cdot}SiH_2$

**Rule 70.11** Cyclic compounds having the formula $[SiH_2{\cdot}S]_n$ will have the generic name cyclo*silthianes* and will be named similarly to the *cyclo*silazanes.

*Example*: *cyclo*Trisilthiane $S{\cdot}SiH_2{\cdot}S{\cdot}SiH_2{\cdot}S{\cdot}SiH_2$

**Rule 70.12** Cyclic compounds having the formula $[SiH_2{\cdot}O]_n$ will have the generic name cyclo*siloxanes* and will be named similarly to the *cyclo*silazanes.

*Example*: *cyclo*Trisiloxane $O{\cdot}SiH_2{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}SiH_2$

**Rule 70.13** *cyclo*Silanes, *cyclo*silazanes, *cyclo*silthianes, and *cyclo*siloxanes will be numbered in the same way as carbon compounds of similar nature.

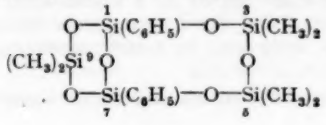
*Examples*: 2-Methoxy*cyclo*trisilazane $HN{\cdot}SiH_2{\cdot}NH{\cdot}SiH_2{\cdot}NH{\cdot}SiH{\cdot}OCH_3$
2-Methoxy*cyclo*trisilthiane $S{\cdot}SiH_2{\cdot}S{\cdot}SiH_2{\cdot}S{\cdot}SiH{\cdot}OCH_3$
2-Methoxy*cyclo*trisiloxane $O{\cdot}SiH_2{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}SiH{\cdot}OCH_3$

[The examples show that O, S, N in the ring take precedence over Si for the number 1. Permanence of this will depend on discussion of the oxa-aza nomenclature now in progress at I.U.P.A.C. Ed.]

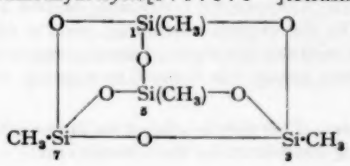
**Rule 70.14** Polycyclic siloxanes (polycyclic compounds whose members consist entirely of alternating silicon and oxygen atoms) will be named as bicyclo*siloxanes*, tricyclo*siloxanes*, etc., or as spiro*siloxanes*, and will be numbered according to methods in use for carbon compounds of similar nature. Polycyclic silthianes, silazanes, and silanes will be treated similarly.

*Examples*:

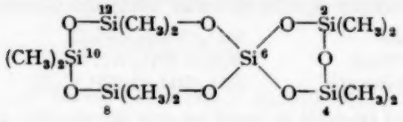
3 : 3 : 5 : 5 : 9 : 9-Hexamethyl-1 : 7-diphenyl*bicyclo*[5 : 3 : 1]pentasiloxane



Tetramethyl*tricyclo*[3 : 3 : 1 : $1^{3,7}$]tetrasiloxane



Decamethyl*spiro*[5 : 7]hexasiloxane



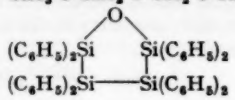
**Rule 70.15** * The names of compounds containing silicon atoms as hetero-members (with or without other hetero-members) but not classifiable as (linear or cyclic) silanes, silazanes, silthianes, or siloxanes will be derived with the aid of the oxa-aza convention.

*Examples* :

**2 : 2 : 4 : 4 : 6 : 6-Hexamethyl-2 : 4 : 6-trisilaheptane** $(CH_3)_3Si{\cdot}CH_2{\cdot}Si(CH_3)_2{\cdot}CH_2{\cdot}Si(CH_3)_3$

**2 : 4 : 6 : 8-Tetraoxa-5-carbanonasilane** $SiH_3{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}CH_2{\cdot}O{\cdot}SiH_2{\cdot}O{\cdot}SiH_3$

Octaphenyloxa*cyclo*pentasilane

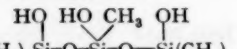


**Rule 70.16** Hydroxy-derivatives in which the hydroxyl groups are attached to a silicon atom will be named by adding the suffixes *ol, diol, triol,* etc., to the name of the parent compound.

| | | | | |
|---|---|---|---|---|
| *Examples* : | Silanol | $H_3Si{\cdot}OH$ | Disiloxanol | $H_3Si{\cdot}O{\cdot}SiH_2{\cdot}OH$ |
| | Silanediol | $H_2Si(OH)_2$ | *cyclo*Hexasilanol | $SiH_2{\cdot}SiH_2{\cdot}SiH{\cdot}OH$ |
| | Silanetriol | $HSi(OH)_3$ | | $SiH_2{\cdot}SiH_2{\cdot}SiH_2$ |
| | Disilanehexol | $(HO)_3Si{\cdot}Si(OH)_3$ | | |

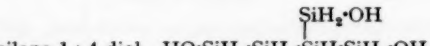
Polyhydroxy-derivatives in which each hydroxyl group is attached to a silicon atom will be named wherever possible in accordance with the principle of treating like things alike.

*Example* : **1 : 1 : 3 : 5 : 5-Pentamethyltrisiloxane-1 : 3 : 5-triol**



Otherwise they shall be named in accordance with the principle of the largest parent compound.

*Example* : **2-Hydroxysilyltetrasilane-1 : 4-diol**



**Rule 70.17** Substituents other than hydroxyl groups (functional atoms or groups and hydrocarbon radicals) attached to silicon will be expressed by appropriate prefixes or suffixes.

| | | |
|---|---|---|
| *Examples* : | Ethyldisilane | $CH_3{\cdot}CH_2{\cdot}SiH_2{\cdot}SiH_3$ |
| | Hexachlorodisiloxane | $Cl_3Si{\cdot}O{\cdot}SiCl_3$ |
| | Dibutyldichlorosilane | $(CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2)_2SiCl_2$ |
| | Silylamine | $H_3Si{\cdot}NH_2$ |
| | Silanediamine | $H_2Si(NH_2)_2$ |
| | Silanetriamine | $HSi(NH_2)_3$ |
| | *N*-Methylsilylamine | $H_3Si{\cdot}NH{\cdot}CH_3$ |
| | *NN*-Dimethylsilylamine | $H_3Si{\cdot}N(CH_3)_2$ |
| | *NN'*-Dimethylsilanediamine | $H_2Si(NH{\cdot}CH_3)_2$ |
| | *NN'N''*-Trimethylsilanetriamine | $HSi(NH{\cdot}CH_3)_3$ |
| | Acetoxytrimethylsilane | $(CH_3)_3Si{\cdot}O{\cdot}OC{\cdot}CH_3$ |
| | Diacetoxydimethylsilane | $(CH_3)_2Si(O{\cdot}OC{\cdot}CH_3)_2$ |

**Rule 70.18** Compounds containing carbon as well as silicon and in which there is a " reactive group " in the carbon-containing portion of the molecule not shared by a silicon atom are named in terms of the organic parent compound wherever feasible. For the purposes of this rule, a " reactive group " is defined as a group which may be designated by a suffix according to Rule 52.

* Note : This rule is subject to the possible extensions of the oxa-aza convention which are now being considered by the Commission.

| | | |
|---|---|---|
| *Examples*: | α-Trimethylsilylacetanilide | $(CH_3)_3Si{\cdot}CH_2{\cdot}CO{\cdot}NH{\cdot}C_6H_5$ |
| | 1-Trichlorosilylethanol | $Cl_3Si{\cdot}CH(OH){\cdot}CH_3$ |
| | 2-Trimethylsilylethanol | $(CH_3)_3Si{\cdot}CH_2{\cdot}CH_2{\cdot}OH$ |
| | (Hydroxydimethylsilyl)methanol | $(CH_3)_2\overset{\displaystyle OH}{\underset{|}{Si}}{\cdot}CH_2{\cdot}OH$ |
| | α-(Hydroxydimethylsilyl)acetanilide | $(CH_3)_2\overset{\displaystyle OH}{\underset{|}{Si}}{\cdot}CH_2{\cdot}CO{\cdot}NH{\cdot}C_6H_5$ |
| | (Silylmethyl)amine | $H_3Si{\cdot}CH_2{\cdot}NH_2$ |
| But by rules 70.16 and 70.17: | | |
| | (Methoxymethyl)silanol | $CH_3O{\cdot}CH_2{\cdot}SiH_2{\cdot}OH$ |
| | *N*-Methylsilylamine | $H_3Si{\cdot}NH{\cdot}CH_3$ |

**Rule 70.19** Compounds in which metals are combined directly with silicon are, in general, named as derivatives of the metal.

*Example*: (Triphenylsilyl)lithium $(C_6H_5)_3SiLi$

However, in exceptional cases, the metal may be named as a substituent.

*Example*: Sodium *p*-(sodiosilyl)benzoate $p$-$NaO_2C{\cdot}C_6H_4{\cdot}SiH_2Na$

**Rule 70.20** Metallic salts of hydroxy-derivatives may be named in the customary manner.

*Example*: Sodium salt of triphenylsilanol $(C_6H_5)_3Si{\cdot}ONa$

## Extended Examples of Radical Names

The purpose of the "extended examples of radical names" is to illustrate further the application of the formal rules given in the preceding document.[1] Certain other preferences and recommendations of the Commission which may be used as a guide in interpreting the rules or in naming some other types of radicals are indicated under the appropriate headings below.

### Rule 54.1 Alkyl Radicals

Typical formula and numbering: Pentyl $\overset{5}{C}H_3{\cdot}\overset{4}{C}H_2{\cdot}\overset{3}{C}H_2{\cdot}\overset{2}{C}H_2{\cdot}\overset{1}{C}H_2-$

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| Methyl | $CH_3-$ | Octadecyl | $CH_3{\cdot}[CH_2]_{16}{\cdot}CH_2-$ |
| Ethyl | $CH_3{\cdot}CH_2-$ | Nonadecyl | $CH_3{\cdot}[CH_2]_{17}{\cdot}CH_2-$ |
| Propyl | $CH_3{\cdot}CH_2{\cdot}CH_2-$ | Eicosyl | $CH_3{\cdot}[CH_2]_{18}{\cdot}CH_2-$ |
| Butyl | $CH_3{\cdot}[CH_2]_2{\cdot}CH_2-$ | Heneicosyl | $CH_3{\cdot}[CH_2]_{19}{\cdot}CH_2-$ |
| Pentyl, replacing amyl | $CH_3{\cdot}[CH_2]_3{\cdot}CH_2-$ | Docosyl | $CH_3{\cdot}[CH_2]_{20}{\cdot}CH_2-$ |
| | | Tricosyl | $CH_3{\cdot}[CH_2]_{21}{\cdot}CH_2-$ |
| Hexyl | $CH_3{\cdot}[CH_2]_4{\cdot}CH_2-$ | Tetracosyl | $CH_3{\cdot}[CH_2]_{22}{\cdot}CH_2-$ |
| Heptyl | $CH_3{\cdot}[CH_2]_5{\cdot}CH_2-$ | Pentacosyl | $CH_3{\cdot}[CH_2]_{23}{\cdot}CH_2-$ |
| Octyl | $CH_3{\cdot}[CH_2]_6{\cdot}CH_2-$ | Hexacosyl | $CH_3{\cdot}[CH_2]_{24}{\cdot}CH_2-$ |
| Nonyl | $CH_3{\cdot}[CH_2]_7{\cdot}CH_2-$ | Heptacosyl | $CH_3{\cdot}[CH_2]_{25}{\cdot}CH_2-$ |
| Decyl | $CH_3{\cdot}[CH_2]_8{\cdot}CH_2-$ | Octacosyl | $CH_3{\cdot}[CH_2]_{26}{\cdot}CH_2-$ |
| Undecyl, replacing hendecyl | $CH_3{\cdot}[CH_2]_9{\cdot}CH_2-$ | Nonacosyl | $CH_3{\cdot}[CH_2]_{27}{\cdot}CH_2-$ |
| | | Triacontyl | $CH_3{\cdot}[CH_2]_{28}{\cdot}CH_2-$ |
| Dodecyl | $CH_3{\cdot}[CH_2]_{10}{\cdot}CH_2-$ | Hentriacontyl | $CH_3{\cdot}[CH_2]_{29}{\cdot}CH_2-$ |
| Tridecyl | $CH_3{\cdot}[CH_2]_{11}{\cdot}CH_2-$ | Dotriacontyl | $CH_3{\cdot}[CH_2]_{30}{\cdot}CH_2-$ |
| Tetradecyl | $CH_3{\cdot}[CH_2]_{12}{\cdot}CH_2-$ | Tritriacontyl | $CH_3{\cdot}[CH_2]_{31}{\cdot}CH_2-$ |
| Pentadecyl | $CH_3{\cdot}[CH_2]_{13}{\cdot}CH_2-$ | Tetracontyl | $CH_3{\cdot}[CH_2]_{38}{\cdot}CH_2-$ |
| Hexadecyl, replacing cetyl | $CH_3{\cdot}[CH_2]_{14}{\cdot}CH_2-$ | Pentacontyl | $CH_3{\cdot}[CH_2]_{48}{\cdot}CH_2-$ |
| | | Hexacontyl | $CH_3{\cdot}[CH_2]_{58}{\cdot}CH_2-$ |
| Heptadecyl | $CH_3{\cdot}[CH_2]_{15}{\cdot}CH_2-$ | | |

[1] Cf. p. 5064.

**Rule 54.2** *iso*ALKYL RADICALS

| *Radical name* | *Formula* |
|---|---|
| (for unsubstituted radicals only) | |
| *iso*Propyl, replacing *sec.*-propyl | $(CH_3)_2CH-$ |
| *iso*Butyl | $(CH_3)_2CH\cdot CH_2-$ |
| *iso*Pentyl, replacing *iso*amyl | $(CH_3)_2CH\cdot CH_2\cdot CH_2-$ |
| *iso*Hexyl | $(CH_3)_2CH\cdot[CH_2]_2\cdot CH_2-$ |
| Note, however : | |
| 5-Methylhexyl | $(CH_3)_2CH\cdot[CH_2]_3\cdot CH_2-$ |

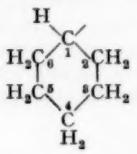
**Rule 54.3** BRANCHED ALKYL RADICALS

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| 2-Methylpentyl | $\overset{5}{C}H_3\cdot\overset{4}{C}H_2\cdot\overset{3}{C}H_2\cdot\overset{2}{C}H(CH_3)\cdot\overset{1}{C}H_2-$ |
| *Recommended exceptions* (for unsubstituted radicals only) : | |
| *sec.*-Butyl | $CH_3\cdot CH_2\cdot CH(CH_3)-$ |
| *tert.*-Butyl | $(CH_3)_3CH-$ |
| *neo*Pentyl | $(CH_3)_3C\cdot CH_2-$ |

**Rule 54.4** ALICYCLIC RADICALS

Typical formula and numbering :

*cyclo*Hexyl



| *Radical name* | *Formula* |
|---|---|
| *cyclo*Propyl | $[CH_2]_2>CH-$ |
| *cyclo*Butyl | $[CH_2]_3>CH-$ |
| *cyclo*Pentyl | $[CH_2]_4>CH-$ |
| *cyclo*Hexyl | $[CH_2]_5>CH-$ |
| *cyclo*Heptyl | $[CH_2]_6>CH-$ |

**Rule 55.1** UNSATURATED ALIPHATIC AND ALICYCLIC RADICALS

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| Ethynyl | $CH{:}C-$ |
| *iso*Propenyl (for unsubstituted radicals only), preferred to 1-methylvinyl | $CH_2{:}C(CH_3)-$ |
| Prop-1-ynyl | $CH_3\cdot C{:}C-$ |
| Prop-2-ynyl, replacing propargyl | $CH{:}C\cdot CH_2-$ |
| Propenyl (=prop-1-enyl) | $CH_3\cdot CH{:}CH-$ |
| Butenyl (-2- shown; replacing crotyl) | $CH_3\cdot CH{:}CH\cdot CH_2-$ |
| Butadienyl (-1 : 3- shown) | $CH_2{:}CH\cdot CH{:}CH-$ |
| 2-Methylallyl, preferred to methallyl | $CH_2{:}C(CH_3)\cdot CH_2-$ |
| Pentenyl (-2- shown) | $CH_3\cdot CH_2\cdot CH{:}CH\cdot CH_2-$ |
| *cyclo*Pentenyl (-2- shown) | $CH_2\cdot CH_2\cdot CH{:}CH\cdot CH-$ |
| *cyclo*Pentadienyl (-2 : 4- shown) | $CH{:}CH\cdot CH{:}CH\cdot CH-$ |
| *cyclo*Hexenyl (-2- shown) | $CH_2\cdot[CH_2]_2\cdot CH{:}CH\cdot CH-$ |
| *cyclo*Hexadienyl (-2 : 4- shown) | $CH_2\cdot CH{:}CH\cdot CH{:}CH\cdot CH-$ |

| *Radical name* | *Formula* |
|---|---|
| *Recommended exceptions* : | |
| Vinyl, preferred to ethenyl | $CH_2{:}CH-$ |
| Allyl, preferred to prop-2-enyl | $CH_2{:}CH{\cdot}CH_2-$ |
| *Geranyl, preferred to 3 : 7-dimethylocta-*trans*-2 : 6(or 7)-dienyl | $C_{10}H_{17}-$ |
| *Linalyl | $C_{10}H_{17}-$ |
| *Neryl, preferred to 3 : 7-dimethylocta-*cis*-2 : 6(or 7)-dienyl | $C_{10}H_{17}-$ |
| *Phytyl, preferred to 3 : 7 : 11 : 15-tetramethylhexadec-2-enyl | $C_{20}H_{39}-$ |

**Rule 56.1** PROPYLIDENE, ETC.

(1) *Saturated aliphatic radicals* (parent radicals derived by rules 54.1, 54.2, and 54.3)

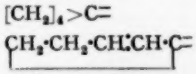
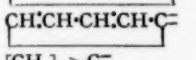
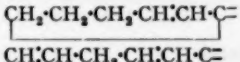
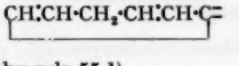
| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| *Regularly formed* | | *Regularly formed* | |
| Methylidyne | $CH{\equiv}$ | Pentylidene | $CH_3{\cdot}[CH_2]_3{\cdot}CH{=}$ |
| Ethylidene | $CH_3{\cdot}CH{=}$ | Pentylidyne | $CH_3{\cdot}[CH_2]_3{\cdot}C{\equiv}$ |
| Ethylidyne | $CH_3{\cdot}C{\equiv}$ | **iso*Pentylidene | $(CH_3)_2CH{\cdot}CH_2{\cdot}CH{=}$ |
| Propylidene | $CH_3{\cdot}CH_2{\cdot}CH{=}$ | **iso*Pentylidyne | $(CH_3)_2CH{\cdot}CH_2{\cdot}C{\equiv}$ |
| Propylidyne | $CH_3{\cdot}CH_2{\cdot}C{\equiv}$ | 2-Methylpentylidene | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){\cdot}CH{=}$ |
| **iso*Propylidene | $(CH_3)_2C{=}$ | 2-Methylpentylidyne | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){\cdot}C{\equiv}$ |
| Butylidene | $CH_3{\cdot}[CH_2]_2{\cdot}CH{=}$ | Hexylidene | $CH_3{\cdot}[CH_2]_4{\cdot}CH{=}$ |
| Butylidyne | $CH_3{\cdot}[CH_2]_2{\cdot}C{\equiv}$ | Hexylidyne | $CH_3{\cdot}[CH_2]_4{\cdot}C{\equiv}$ |
| **iso*Butylidene | $(CH_3)_2CH{\cdot}CH{=}$ | **iso*Hexylidene | $(CH_3)_2CH{\cdot}[CH_2]_2{\cdot}CH{=}$ |
| **sec.*-Butylidene | $CH_3{\cdot}CH_2{\cdot}C(CH_3){=}$ | **iso*Hexylidyne | $(CH_3)_2CH{\cdot}[CH_2]_2{\cdot}C{\equiv}$ |
| **iso*Butylidyne | $(CH_3)_2CH{\cdot}C{\equiv}$ | | |
| *Exception* : | | | |
| Methylene | $CH_2{=}$ | | |

* Recommended for unsubstituted radicals only.

Compound radical names may be formed from these in the usual manner :

| *Radical name* | *Formula* |
|---|---|
| Naphthylmethylene [2] (2- shown) | $2\text{-}C_{10}H_7{\cdot}CH{=}$ |
| Naphthylmethylidyne (2- shown) | $2\text{-}C_{10}H_7{\cdot}C{\equiv}$ |

(2) *Alicyclic radicals* (parent radicals derived by rules 54.4 and 55.1)

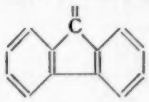
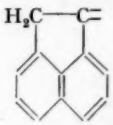
| | |
|---|---|
| *cyclo*Pentylidene | $[CH_2]_4{>}C{=}$ |
| *cyclo*Pentenylidene (-2- shown) |  |
| *cyclo*Pentadienylidene (-2 : 4- shown) |  |
| *cyclo*Hexylidene | $[CH_2]_5{>}C{=}$ |
| *cyclo*Hexenylidene (-2- shown) |  |
| *cyclo*Hexadienylidene (-2 : 5- shown) |  |

(3) *Unsaturated aliphatic radicals* (parent radicals derived by rule 55.1)

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| Butenylidene (-2- shown) | $CH_3{\cdot}CH{:}CH{\cdot}CH{=}$ |
| Butenylidyne (-2- shown) | $CH_3{\cdot}CH{:}CH{\cdot}C{\equiv}$ |
| *Recommended exceptions* : | |
| Vinylidene, preferred to ethenylidene | $CH_2{:}C{=}$ |
| Allylidene, preferred to prop-2-enylidene | $CH_2{:}CH{\cdot}CH{=}$ |

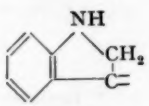
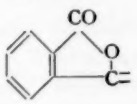
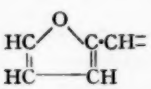
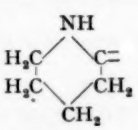
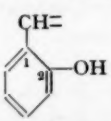
[2] This accords with British practice. The radical has been named naphthylene in U.S.A.

(4) (parent radicals derived in other ways)

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| Benzylidene (rule 61.1) | $C_6H_5 \cdot CH=$ |
| Benzylidyne (rule 61.1) | $C_6H_5 \cdot C\equiv$ |
| *iso*Propylbenzylidene | $(CH_3)_2CH \cdot C_6H_4 \cdot CH=$ |
| Cinnamylidene (rule 61.1) | $C_6H_5 \cdot CH{:}CH \cdot CH=$ |
| Fluorenylidene (rule 59.1) |  |
| Acenaphthenylidene (rule 59.1) |  |

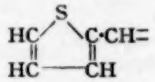
**Rule 56.2** ACETONYLIDENE, ETC.

(1) *Parent radicals connected with other rules*

| *Parent radical* | *Multivalent radical* | *Formula of multivalent radical* |
|---|---|---|
| *See Rule* 60.1 : | | |
| Indolinyl | Indolinylidene (3- shown) |  |
| Phthalidyl | Phthalidylidene |  |
| *See Rule* 61.1 : | | |
| Furfuryl | Furfurylidene (2- only) |  |
| Piperidyl | Piperidylidene (2- shown) |  |
| Phenacyl | Phenacylidene | $C_6H_5 \cdot CO \cdot CH=$ |
| 3 : 4-Methylenedioxybenzyl [3] | Piperonylidene | $3:4:1\text{-}CH_2O_2{:}C_6H_3 \cdot CH=$ |
| *o*-Hydroxybenzyl [4] | Salicylidene |  |

[3] This name is used in Chemical Society publications in preference to piperonyl (which is given in the I.U.P.A.C. text), owing to possible confusion with $3:4:1\text{-}CH_2O_2{:}C_6H_3-$ (cf. Mitchell, *op. cit.*, p. 87; *J.*, 1951, 3519). However, for the bivalent radical piperonylidene no confusion is possible.

[4] Salicyl in the I.U.P.A.C. text; cf. footnote 3.

| *Parent radical* | *Multivalent radical* | *Formula of multivalent radical* |
|---|---|---|
| Thenyl [5] | Thenylidene (2- shown) |  |
| 4-Hydroxy-3-methoxybenzyl [6] | Vanillylidene | 3 : 4 : 1-$CH_3O{\cdot}C_6H_3(OH){\cdot}CH{=}$ |

(2) *Parent radicals not connected with other rules*

| | | |
|---|---|---|
| Acetonyl | Acetonylidene | $CH_3{\cdot}CO{\cdot}CH{=}$ |

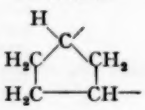
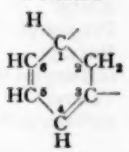
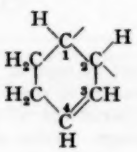
**Rule 57.1** TRIMETHYLENE, ETC.

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| *Regularly formed* | | *Regularly formed* | |
| Ethylene | $-CH_2{\cdot}CH_2-$ | Hexamethylene | $-CH_2{\cdot}[CH_2]_4{\cdot}CH_2-$ |
| Trimethylene | $-CH_2{\cdot}CH_2{\cdot}CH_2-$ | | |
| Tetramethylene | $-CH_2{\cdot}[CH_2]_2{\cdot}CH_2-$ | *Recommended exception* : | |
| Pentamethylene | $-CH_2{\cdot}[CH_2]_3{\cdot}CH_2-$ | Propylene | $CH_3{\cdot}\underset{|}{C}H{\cdot}CH_2-$ |

**Rule 57.2** BUTENYLENE, ETC.

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| *Regularly formed* | | *Recommended exception* : | |
| Propenylene | $-CH_2{\cdot}CH{:}CH-$ | Vinylene, preferred to ethenylene | $-CH{:}CH-$ |
| Butenylene (-2- shown) | $-CH_2{\cdot}CH{:}CH{\cdot}CH_2-$ | | |
| Ethynylene | $-C{:}C-$ | | |

**Rule 57.3** *cyclo*PENTYLENE, ETC.

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| *cyclo*Pentylene, *cyclo*pent-1 : 3-ylene shown |  | *cyclo*Hexadienylene (*cyclo*hexa-3 : 5-dien-1 : 3-ylene shown) |  |
| *cyclo*Hexenylene (*cyclo*hex-3-en-1 : 2-ylene shown) |  | | |

**Rule 58.1** CARBONYL

| *Parent acid ending* | *Parent radical ending* | *Formula* |
|---|---|---|
| Carboxylic | Carbonyl | $-CO-$ |

Note : In general this ending for the names of acid radicals is to be restricted to cases where a name ending in *oyl* is not practicable.

*Examples* :

| | |
|---|---|
| *cyclo*Hexanecarbonyl chloride | $C_6H_{11}{\cdot}COCl$ |
| Methoxycarbonyl [7] | $CH_3O{\cdot}CO-$ |
| Propanetricarbonyl (-1 : 2 : 3- shown) | $-CO{\cdot}CH_2{\cdot}\underset{|}{C}H{\cdot}CH_2{\cdot}CO-$ <br> $CO-$ |

**Rule 58.2** SULPHONYL, ETC.

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| Sulphonyl | $-SO_2-$ | Benzenesulphonyl | $C_6H_5{\cdot}SO_2-$ |
| Sulphinyl | $-SO-$ | Benzenesulphinyl | $C_6H_5{\cdot}SO-$ |

[5] Since thienyl, the radical from thiophen is so very similar, thienylmethyl will also be accepted in Chemical Society publications.

[6] Vanillyl in the I.U.P.A.C. text; cf. footnote 3.

[7] See footnote 12 below and p. 5062.

The following names are also recommended :

| | |
|---|---|
| Sulphanilyl | $p$-$NH_2 \cdot C_6H_4 \cdot SO_2-$ |
| Toluene-$p$-sulphonyl<br>$p$-Tolylsulphonyl } preferred to tosyl [8] | $p$-$CH_3 \cdot C_6H_4 \cdot SO_2-$ |

(Note : tosyl is recommended only for $p$-isomer.)

Note the following difference in additive and substitutive names : [9]

| | |
|---|---|
| Benzenesulphonyl chloride [9] | $C_6H_5 \cdot SO_2Cl$ |
| Phenylsulphonylacetic acid [9] | $C_6H_5 \cdot SO_2 \cdot CH_2 \cdot CO_2H$ |

and so for sulphinyl, etc.

**Rule 58.3** OYL RADICALS

The Commission favours in principle the use of systematic names for the higher saturated monobasic and dibasic aliphatic acids, *i.e.*, those with more than five carbon atoms, and their radicals when substituents are present. The Commission also recommends that the carboxyl-carbon atom be always numbered as 1 whether the name be a Geneva name or a trivial name, but not when it is a " carbonyl " name.[10]

*Examples of numbering* :

hexanoyl $\overset{6}{C}H_3 \cdot \overset{5}{C}H_2 \cdot \overset{4}{C}H_2 \cdot \overset{3}{C}H_2 \cdot \overset{2}{C}H_2 \cdot \overset{1}{C}O-$

hexanedioyl<br>adipoyl } $-\overset{6}{C}O \cdot \overset{5}{C}H_2 \cdot \overset{4}{C}H_2 \cdot \overset{3}{C}H_2 \cdot \overset{2}{C}H_2 \cdot \overset{1}{C}O-$

(1) *Saturated aliphatic monocarboxylic acid radicals*

| *Radical name* | *Formula* |
|---|---|
| Formyl | $H \cdot CO-$ |
| Acetyl | $CH_3 \cdot CO-$ |
| Propionyl | $CH_3 \cdot CH_2 \cdot CO-$ |
| Butyryl | $CH_3 \cdot [CH_2]_2 \cdot CO-$ |
| *iso*Butyryl [11] | $(CH_3)_2CH \cdot CO-$ |
| Valeryl | $CH_3 \cdot [CH_2]_3 \cdot CO-$ |
| *iso*Valeryl [11] | $(CH_3)_2CH \cdot CH_2 \cdot CO-$ |

---

[8] The text seems to mean that (*a*) tosyl should not be used at all, but (*b*), if it is used, then it shall be confined to the $p$-isomer. This approximates to present Chemical Society practice (which will therefore not be changed) that tosyl is permitted as a prefix in carbohydrate and steroid chemistry (owing to long usage) but not elsewhere. Tosic acid, tosate, and tosylate, are not permitted, nor, in Chemical Society publications, is tosyl chloride. See also footnote 9.

[9] The difference requires consideration in the light of rules 25, 47, and 58.2. When a radical $R \cdot SO_2-$ is attached to Cl, $NH_2$, etc., the substance is named as a derivative of the acid $R \cdot SO_3H$, *e.g.*, it is the acid chloride or amide of benzenesulphonic acid, the sulphonic acid group being inserted, as a suffix, into the benzene molecule name. When, however, $R \cdot SO_2-$ is attached to carbon, then the group $R \cdot SO_2-$ is considered to be a substituent in another molecule and is named as phenylsulphonyl, *i.e.*, the phenyl radical $C_6H_5-$ and the bivalent sulphonyl radical $-SO_2-$ are juxtaposed by additive nomenclature.

This difference is carried over to more complex radicals formed from $R \cdot SO_2-$. Thus one has β-benzenesulphonamidopropionic acid $C_6H_5 \cdot SO_2 \cdot NH \cdot CH_2 \cdot CH_2 \cdot CO_2H$, but phenylsulphonyl-propionic acid $C_6H_5 \cdot SO_2 \cdot CH_2 \cdot CH_2 \cdot CO_2H$; and toluene-$p$-sulphonamidothiophen, but $p$-tolyl-sulphonylthiophen (or, in Chemical Society practice, alternatively, thienyl $p$-tolyl sulphone).

[10] This corresponds in the main to current Chemical Society practice. The last phrase means that when, for instance, hexanoic acid is named pentane-1-carboxylic acid the $CO_2H$ group is not numbered and the α-carbon atom then (but only then) bears the number 1. However, when trivial names are used for lower members of the series, Greek letters are employed in Chemical Society publications, and the $CO_2H$ group is not specified; this does not conform to I.U.P.A.C. rules but is considered wise because of past variations in Chemical Society numbering for these acids.

[11] Presumably the *iso*-acid names may be used only for the unsubstituted acids as this principle applies to *iso*-hydrocarbon names.

| *Radical name* | *Systematic name* | *Formula* |
|---|---|---|
| Hexanoyl, replacing caproyl | | $CH_3 \cdot [CH_2]_4 \cdot CO-$ |
| Heptanoyl, replacing enanthoyl, œnanthyl, etc. | | $CH_3 \cdot [CH_2]_5 \cdot CO-$ |
| Octanoyl, replacing capryloyl and caprylyl | | $CH_3 \cdot [CH_2]_6 \cdot CO-$ |
| Nonanoyl, replacing pelargonoyl and pelargonyl | | $CH_3 \cdot [CH_2]_7 \cdot CO-$ |
| Decanoyl, replacing caprinoyl and capryl | | $CH_3 \cdot [CH_2]_8 \cdot CO-$ |
| Undecanoyl | | $CH_3 \cdot [CH_2]_9 \cdot CO-$ |
| Lauroyl | Dodecanoyl | $CH_3 \cdot [CH_2]_{10} \cdot CO-$ |
| Tridecanoyl | | $CH_3 \cdot [CH_2]_{11} \cdot CO-$ |
| Myristoyl | Tetradecanoyl | $CH_3 \cdot [CH_2]_{12} \cdot CO-$ |
| Pentadecanoyl | | $CH_3 \cdot [CH_2]_{13} \cdot CO-$ |
| Palmitoyl | Hexadecanoyl | $CH_3 \cdot [CH_2]_{14} \cdot CO-$ |
| Heptadecanoyl | | $CH_3 \cdot [CH_2]_{15} \cdot CO-$ |
| Stearoyl | Octadecanoyl | $CH_3 \cdot [CH_2]_{16} \cdot CO-$ |

The following radicals are named in like manner :

| | |
|---|---|
| Acetoacetyl | $CH_3 \cdot CO \cdot CH_2 \cdot CO-$ |
| Phenylacetyl | $C_6H_5 \cdot CH_2 \cdot CO-$ |

(2) *Saturated normal aliphatic dicarboxylic acid radicals*

| | | |
|---|---|---|
| Oxalyl | | $-CO \cdot CO-$ |
| Malonyl | | $-CO \cdot CH_2 \cdot CO-$ |
| Succinyl | | $-CO \cdot [CH_2]_2 \cdot CO-$ |
| Glutaryl | | $-CO \cdot [CH_2]_3 \cdot CO-$ |
| Adipoyl | Hexanedioyl | $-CO \cdot [CH_2]_4 \cdot CO-$ |
| Pimeloyl | Heptanedioyl | $-CO \cdot [CH_2]_5 \cdot CO-$ |
| Suberoyl | Octanedioyl | $-CO \cdot [CH_2]_6 \cdot CO-$ |
| Azelaoyl | Nonanedioyl | $-CO \cdot [CH_2]_7 \cdot CO-$ |
| Sebacoyl | Decanedioyl | $-CO \cdot [CH_2]_8 \cdot CO-$ |

The following radical is named in like manner :

| | |
|---|---|
| Mesoxalyl | $-CO \cdot CO \cdot CO-$ |

(3) *RO·CO– radicals*

| | |
|---|---|
| Methoxycarbonyl, replacing carbomethoxy [12] | $CH_3O \cdot CO-$ |
| Ethoxycarbonyl, replacing carbethoxy [12] | $CH_3 \cdot CH_2 \cdot O \cdot CO-$ |

Note : These are recommended prototypes of the more general series of the radicals $RO \cdot CO-$.[12]

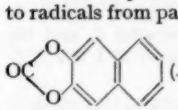
(4) *RO·CO·CO– radicals*

| | |
|---|---|
| Methoxalyl | $CH_3O \cdot CO \cdot CO-$ |
| Ethoxalyl | $C_2H_5O \cdot CO \cdot CO-$ |

---

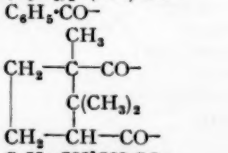
[12] This important change is accepted by the Chemical Society. The names carbomethoxy and carbethoxy are of long standing and convenient, but this type of name rapidly becomes cumbrous, *e.g.*, carbo-*tert.*-butoxy, carbo-*p*-nitrobenzyloxy, etc. The new method is more convenient in that it names the radicals in the order in which they appear in the formula, *e.g.*, $CH_2Ph \cdot O \cdot CO$ benzyloxycarbonyl. However, this is additive nomenclature—the alkoxyl radical RO– is added to the bivalent carbonyl radical –CO–; most nomenclature is based on the substitutive principle, and adoption of the alkoxycarbonyl names does not mean that the Chemical Society has abandoned the use of substitutive nomenclature wherever this may be practicable. Footnote 9, concerning $R \cdot SO_2-$, should, however, be noted.

The new practice incidentally provides also a convenient method of assigning prefix names to radicals from partial esters of polybasic acids, *e.g.*, $CH_2Ph \cdot O \cdot CO \cdot O-$ is now benzyloxycarbonyloxy; $EtO \cdot SO_2 \cdot O-$ is ethoxysulphonyloxy; $MeO \cdot PO_2 \cdot O-$ is methoxyphosphoryloxy; etc.

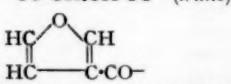

(*A*)

The extended examples (p. 5097) list " carbonyldioxy " as the name for $-O \cdot CO \cdot O-$, but it appears best to restrict its use to cases where this grouping is attached at both ends to one nucleus, as in (*A*), and to use the names benzyloxycarbonyloxy, etc., as outlined in the preceding paragraph.

(5) *Other recommended radical names*

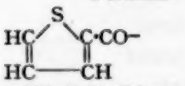
| *Radical name* | *Formula* |
|---|---|
| Acryloyl | $CH_2{:}CH{\cdot}CO-$ |
| Anisoyl (*p*- shown) | $p\text{-}CH_3O{\cdot}C_6H_4{\cdot}CO-$ |
| Anthraniloyl | $o\text{-}NH_2{\cdot}C_6H_4{\cdot}CO-$ |
| Aspartoyl | $-CO{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ |
| Atropoyl, preferred to 2-phenylacryloyl | $C_6H_5{\cdot}C(:CH_2){\cdot}CO-$ |
| Benziloyl | $(C_6H_5)_2C(OH){\cdot}CO-$ |
| Benzoyl | $C_6H_5{\cdot}CO-$ |
| Camphoroyl |  |
| Cinnamoyl | $C_6H_5{\cdot}CH{:}CH{\cdot}CO-$ |
| Citraconoyl | $-CO{\cdot}C(CH_3){:}CH{\cdot}CO-$ (*cis*) |
| Crotonoyl, preferred to *trans*-but-2-enoyl | $CH_3{\cdot}CH{:}CH{\cdot}CO-$ |
| 3 : 4-Dimethoxyphenylacetyl, replacing homoveratroyl | $3:4:1\text{-}(CH_3O)_2C_6H_3{\cdot}CH_2{\cdot}CO-$ |

Note : in the same way other " homo " names.

| | |
|---|---|
| Dimethylbenzoyl (2 : 3- shown), replacing xyloyl [13] | $2:3:1\text{-}(CH_3)_2C_6H_3{\cdot}CO-$ |
| *p-iso*Propylbenzoyl, replacing cumoyl | $p\text{-}(CH_3)_2CH{\cdot}C_6H_4{\cdot}CO-$ |
| Fumaroyl | $-CO{\cdot}CH{:}CH{\cdot}CO-$ (*trans*) |
| Furoyl (3- shown) |  |
| Galloyl | $3:4:5:1\text{-}(HO)_3C_6H_2{\cdot}CO-$ |
| Glutamoyl | $-CO{\cdot}CH_2{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ |
| Glyceroyl | $HO{\cdot}CH_2{\cdot}CH(OH){\cdot}CO-$ |
| Glycolloyl | $HO{\cdot}CH_2{\cdot}CO-$ |
| Glyoxyloyl | $OHC{\cdot}CO-$ |
| Hippuroyl | $C_6H_5{\cdot}CO{\cdot}NH{\cdot}CH_2{\cdot}CO-$ |
| Hydratropoyl, preferred to 2-phenylpropionyl | $C_6H_5{\cdot}CH(CH_3){\cdot}CO-$ |
| Lactoyl | $CH_3{\cdot}CH(OH){\cdot}CO-$ |
| Maleoyl | $-CO{\cdot}CH{:}CH{\cdot}CO-$ (*cis*) |
| Maloyl | $-CO{\cdot}CH(OH){\cdot}CH_2{\cdot}CO-$ |
| Mesaconoyl | $-CO{\cdot}C(CH_3){:}CH{\cdot}CO-$ (*trans*) |
| Methacryloyl, preferred to 2-methylacryloyl [14] | $CH_2{:}C(CH_3){\cdot}CO-$ |
| Naphthoyl (2- shown) | $2\text{-}C_{10}H_7{\cdot}CO-$ |
| Oleoyl, preferred to *cis*-octadec-9-enoyl | $CH_3{\cdot}[CH_2]_7{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO-$ |
| Phenylacetyl | $C_6H_5{\cdot}CH_2{\cdot}CO-$ |
| Phthaloyl | $o\text{-}C_6H_4(CO-)_2$ |
| *iso*Phthaloyl | $m\text{-}C_6H_4(CO-)_2$ |
| Piperonyloyl | $3:4:1\text{-}CH_2O_2{:}C_6H_3{\cdot}CO-$ |
| Pivaloyl | $(CH_3)_3C{\cdot}CO-$ |
| Propioloyl | $CH{:}C{\cdot}CO-$ |
| Protocatechuoyl | $3:4:1\text{-}(HO)_2C_6H_3{\cdot}CO-$ |
| Pyruvoyl | $CH_3{\cdot}CO{\cdot}CO-$ |
| Salicyloyl | $o\text{-}HO{\cdot}C_6H_4{\cdot}CO-$ |
| Tartronoyl | $-CO{\cdot}CH(OH){\cdot}CO-$ |
| Terephthaloyl | $p\text{-}C_6H_4(CO-)_2$ |

[13] The CO group carries the number 1. This applies also to toluoyl. It must also apply to the acids themselves; thus, *e.g.*, in *p*-toluic acid the $CO_2H$ group is numbered 1, and the methyl group 4, reversing British practice. The necessary changes to conform to I.U.P.A.C. numbering will be introduced forthwith into Chemical Society publications.

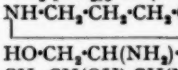
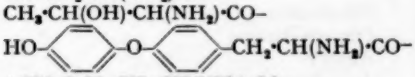
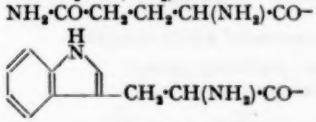
[14] The tentative rules published in 1949 contained methallyl, which was changed to 2-methylallyl during revision in 1951. It may have been an oversight that methacryloyl was allowed to remain unchanged in 1951.

| *Radical name* | *Formula* |
|---|---|
| Thenoyl (2- shown) |  |
| Toluoyl (*o*- shown) [15] | *o*-$CH_3 \cdot C_6H_4 \cdot CO-$ |
| Tropoyl | $C_6H_5 \cdot CH(CH_2 \cdot OH) \cdot CO-$ |
| Vanilloyl | 3 : 4 : 1-$CH_3O \cdot C_6H_3(OH) \cdot CO-$ |
| Veratroyl | 3 : 4 : 1-$(CH_3O)_2C_6H_3 \cdot CO-$ |

**Rule 58.4** AMOYL RADICALS

| *Radical name* [16] | *Formula* | *Radical name* [16] | *Formula* |
|---|---|---|---|
| Carbamoyl | $H_2N \cdot CO-$ | Succinamoyl | $NH_2 \cdot CO \cdot CH_2 \cdot CH_2 \cdot CO-$ |
| Phenylcarbamoyl | $C_6H_5 \cdot NH \cdot CO-$ | Sulphamoyl | $NH_2 \cdot SO_2-$ |
| Oxamoyl | $H_2N \cdot CO \cdot CO-$ | Phenylsulphamoyl | $C_6H_5 \cdot NH \cdot SO_2-$ |
| Phthalamoyl | *o*-$NH_2 \cdot CO \cdot C_6H_4 \cdot CO-$ | | |

**Rule 58.5** AMINO-ACID RADICALS

| *Parent acid* | *Radical name* | *Formula* |
|---|---|---|
| *Regularly formed* | | |
| Alanine | Alanyl | $CH_3 \cdot CH(NH_2) \cdot CO-$ |
| Arginine | Arginyl | $NH_2 \cdot C(:NH) \cdot NH \cdot [CH_2]_3 \cdot CH(NH_2) \cdot CO-$ |
| Cystine | Cystyl | $[\cdot S \cdot CH_2 \cdot CH(NH_2) \cdot CO-]_2$ |
| Glycine | Glycyl | $NH_2 \cdot CH_2 \cdot CO-$ |
| Histidine | Histidyl | $C_3H_3N_2 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Leucine | Leucyl | $(CH_3)_2CH \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| *iso*Leucine | *iso*Leucyl | $C_2H_5 \cdot CH(CH_3) \cdot CH(NH_2) \cdot CO-$ |
| Lysine | Lysyl | $NH_2 \cdot [CH_2]_4 \cdot CH(NH_2) \cdot CO-$ |
| Methionine | Methionyl | $CH_3 \cdot S \cdot CH_2 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Norleucine | Norleucyl | $CH_3 \cdot [CH_2]_3 \cdot CH(NH_2) \cdot CO-$ |
| Ornithine | Ornithyl | $NH_2 \cdot [CH_2]_3 \cdot CH(NH_2) \cdot CO-$ |
| Proline | Prolyl |  |
| Serine | Seryl | $HO \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Threonine | Threonyl | $CH_3 \cdot CH(OH) \cdot CH(NH_2) \cdot CO-$ |
| Thyronine | Thyronyl |  |
| Tyrosine | Tyrosyl | *p*-$HO \cdot C_6H_4 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Valine | Valyl | $(CH_3)_2CH \cdot CH(NH_2) \cdot CO-$ |
| In the same way : | | |
| Taurine | Tauryl | $NH_2 \cdot CH_2 \cdot CH_2 \cdot SO_2-$ |
| *Recommended exceptions* : | | |
| Asparagine | Asparaginyl | $NH_2 \cdot CO \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Cysteine | Cysteinyl | $HS \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Glutamine | Glutaminyl | $NH_2 \cdot CO \cdot CH_2 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Tryptophan | Tryptophyl |  |
| The following names are recommended : [17] | | |
| Aspartic acid | Aspartyl | $HO_2C \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| Glutamic acid | Glutamyl | $HO_2C \cdot CH_2 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| However, according to rule 58.3 : [17] | | |
| | Aspartoyl | $-CO \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |
| | Glutamoyl | $-CO \cdot CH_2 \cdot CH_2 \cdot CH(NH_2) \cdot CO-$ |

[15] Cf. footnote 13. [16] Cf. note to rule 58.4. [17] Cf. note to rule 58.3.

**Rule 58.6** AMIDO-RADICALS

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| Formamido | H·CO·NH– |
| Acetamido | $CH_3$·CO·NH– |
| Propionamido | $CH_3$·$CH_2$·CO·NH– |
| Heptanamido, preferred to hexanecarbonamido [18] | $CH_3$·$[CH_2]_5$·CO·NH– |
| Benzamido | $C_6H_5$·CO·NH– |
| Benzenesulphonamido | $C_6H_5$·$SO_2$·NH– |
| *Recommended exceptions* : | |
| Ureido | $NH_2$·CO·NH– |
| 3-Phenylureido | $C_6H_5$·NH·CO·NH– |

**Rule 58.7** IMIDO-RADICALS

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| Phthalimido | *o*-$C_6H_4(CO)_2N$– | However : | |
| Succinimido | $CH_2$·CO, $CH_2$·CO >N– | Diacetylamino | $(CH_3$·$CO)_2N$– |

**Rule 58.8** IMIDOYL RADICALS

| *Radical name* [19] | *Formula* | *Radical name* [19] | *Formula* |
|---|---|---|---|
| Acetimidoyl | $CH_3$·C(:NH)– | Benzimidoyl | $C_6H_5$·C(:NH)– |

**Rule 58.9** AMINO, ANILINO, ETC.

| *Radical name* | *Formula* |
|---|---|
| *Regularly formed* | |
| Ethylamino | $CH_3$·$CH_2$·NH– |
| Dimethylamino | $(CH_3)_2N$– |
| Anilino | $C_6H_5$·NH– |
| Anisidino (*p*- shown) | *p*-$CH_3O$·$C_6H_4$·NH– |
| Benzidino | *p*-$NH_2$·$C_6H_4$·$C_6H_4$·NH–(*p*) |
| Cumidino | *p*-$(CH_3)_2CH$·$C_6H_4$·NH– |
| Guanidino | $NH_2$·C(:NH)·NH– |
| Phenetidino (*p*- shown) | *p*-$C_2H_5O$·$C_6H_4$·NH– |
| Toluidino (*p*- shown) [20] | *p*-$CH_3$·$C_6H_4$·NH– |
| 2 : 4 : 5-Trimethylanilino, replacing *pseudo*cumidino | 2 : 4 : 5 : 1-$(CH_3)_3C_6H_2$·NH– |
| 2 : 4 : 6-Trimethylanilino, replacing mesidino [21] | 2 : 4 : 6 : 1-$(CH_3)_3C_6H_2$·NH– |
| Xylidino (2 : 3- shown) [20] | 2 : 3 : 1-$(CH_3)_2C_6H_3$·NH– |
| *Other recommended amino-radicals* : | |
| Amidino, replacing guanyl | $NH_2$·C(:NH)– |
| Sulphoamino | $HO_3S$·NH– |

---

[18] Cf. note to rule 32.

[19] Cf. note to rule 58.8.

[20] The numbering of 2 : 3-xylidino shows that the amino-, and not the methyl, group carries the number 1. Thus in *p*-toluidino the NH– and not the $CH_3$ carries the number 1. This will apply necessarily also to the amines themselves and to analogous compounds. The necessary changes will be introduced forthwith in Chemical Society publications. Cf. footnote 13.

[21] The loss of mesidino, but retention of mesityl (cf. p. 5091) and absence of mention of mesitoyl, should be noted.

**Rule 59.1** UNIVALENT AROMATIC RADICALS

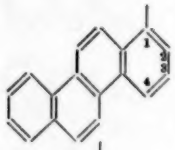
(1) *Numbered from point of attachment*

| *Radical name* | *Formula* |
|---|---|
| *Typical numbering* : | |
| *o*-Tolyl [22] | *o*-$CH_3 \cdot C_6H_4-$ |
| 2 : 4-Xylyl [22] | 2 : 4 : 1-$(CH_3)_2C_6H_3-$ |
| *Regularly formed* | |
| Cumenyl (*m*- shown) | *m*-$(CH_3)_2CH \cdot C_6H_3-$ |
| *Recommended exceptions* : | |
| Phenyl | $C_6H_5-$ |
| Methoxyphenyl (*o*- shown) | *o*-$CH_3O \cdot C_6H_4-$ |
| Tolyl (*o*- shown) | *o*-$CH_3 \cdot C_6H_4-$ |
| Xylyl (2 : 3- shown) [22] | 2 : 3 : 1-$(CH_3)_2C_6H_3-$ |
| Mesityl | 2 : 4 : 6 : 1-$(CH_3)_3C_6H_2-$ |

Note : It is recommended that the systematic names be used for the other polyalkylphenyl radicals.

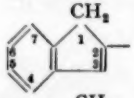
(2) *Fixed numbering*

Chrysenyl (1- shown)

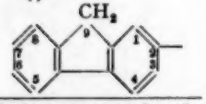


Pyrenyl (1- shown)

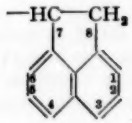
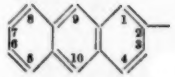
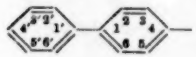
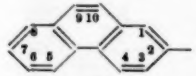
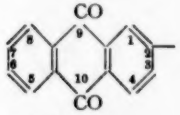
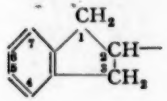
Indenyl (2- shown)



Fluorenyl (2- shown)



[22] The point of attachment, and not the methyl group, carries the number 1. The necessary changes will be introduced forthwith in Chemical Society publications. Cf. footnotes 13 and 20.

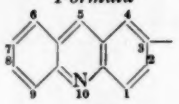
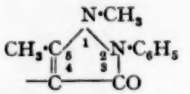
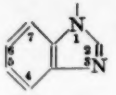
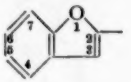
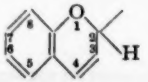
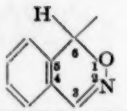
| *Radical name* | *Formula* |
|---|---|
| Acenaphthenyl (7- shown) |  |
| *Recommended exceptions* : | |
| Naphthyl (2- shown) | |
| Anthryl (2- shown) |  |
| Diphenylyl (4- shown) [23] |  |
| Phenanthryl (2- shown) |  |
| *Recommended radical names of related nature* : | |
| Anthraquinonyl (2- shown) |  |
| Indanyl (2- shown) |  |
| Benzoquinonyl (*p*- shown) [24] | |

[23] The unsubstituted radical is called *p*-diphenylyl. The numbering applies to its substituted derivatives.

[24] Note that the numbering does not change when a radical is formed from the parent quinone.

**Rule 60.1** HETEROCYCLIC RADICALS

(The recommended exceptions are indicated by an *)

| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Acridine [25] | Acridinyl (3- shown) |  |
| Antipyrine | Antipyrinyl |  |
| Benziminazole [26] | Benziminazolyl (1- shown) |  |
| Benzofuran [27] | Benzofuranyl (2- shown) |  |
| Benzopyran | Benzopyranyl (1 : 2*H*-Benzopyran-2-yl [28] shown) |  |
| 4 : 5-Benz-1 : 2-oxazine [29] | 4 : 5-Benz-1 : 2-oxazin-6-yl |  |

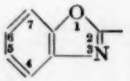
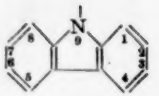
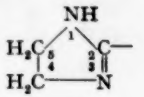
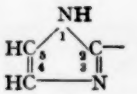
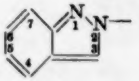
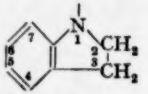
[25] The I.U.P.A.C. text gives the Ring Index numbering (cf. however, the general remarks about the scope of extended examples).

[26] Benzimidazole in the I.U.P.A.C. text.

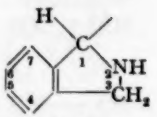
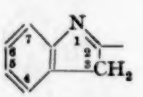
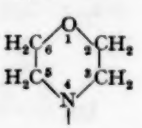
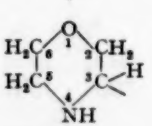
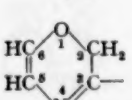
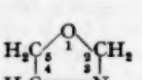
[27] Note that furyl, formed exceptionally from furan, is not permitted in compounds names such as benzofuranyl.

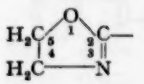
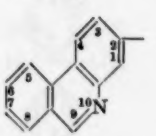
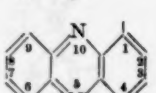
[28] This illustrates the (? tentative) use of *H* to show the position of the "indicated" ("extra") hydrogen atom (cf. p. 5064).

[29] The I.U.P.A.C. text gives Ring Index numbering, modified by the "indicated hydrogen" symbol. British numbering is given above.

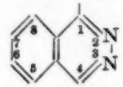
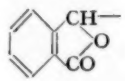
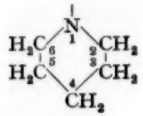
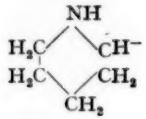
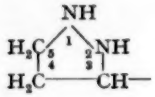
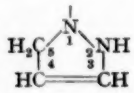
| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Benzoxazole | Benzoxazolyl (2- shown) |  |
| Carbazole | Carbazolyl (9- shown) |  |
| 4 : 5-Dihydro-glyoxaline [30] | 4 : 5-Dihydroglyoxalin-2-yl |  |
| Furan [27] | *Furyl (3- shown) | |
| Glyoxaline [30] | Glyoxalin-2-yl |  |
| Indazole | Indazolyl (2- shown) |  |
| Indoline | Indolinyl (1- shown) |  |

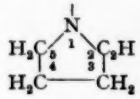
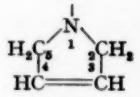
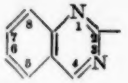
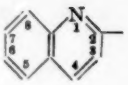
[30] The I.U.P.A.C. text gives imidazole, imidazoline, imidazolidine, and their derived radicals. It gives "imidazolyl, replacing glyoxalyl and glyoxalinyl," but this is an isolated revision of heterocyclic nomenclature, and the Chemical Society will retain its names as given above until the question is considered *in toto* by I.U.P.A.C.

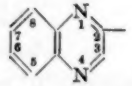
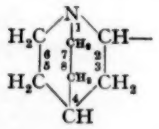
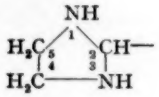
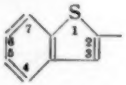
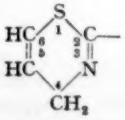
| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| *iso*Indoline | *iso*Indolinyl (1- shown) |  |
| Indole | Indolyl (1- shown) | |
| *iso*Indole | *iso*Indolyl (2- shown) | |
| *pseudo*Indole | *pseudo*Indolyl (3*H*-*pseudo*-Indol-2-yl shown) |  |
| Morpholine | •Morpholino |  |
| | Morpholinyl (3- shown) |  |
| 1 : 4-Oxazine | 1 : 4-Oxazin-3-yl |  |
| Oxazolidine | Oxazolidinyl (3- shown) |  |

| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Oxazoline | $\Delta^2$-Oxazolinyl (-2- shown) [31] |  |
| Oxazole | Oxazolyl (2- shown) | |
| *iso*Oxazole | *iso*Oxazolyl (3- shown) | |
| Pentazole | Pentazolyl | |
| Perimidine | Perimidinyl (2- shown) | |
| Phenanthridine [32] | Phenanthridinyl (2- shown) |  |
| Phenazine | Phenazinyl (1- shown) |  |

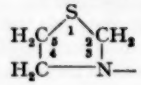
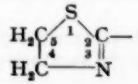
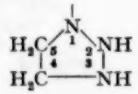
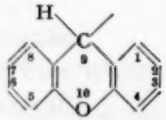
[31] The I.U.P.A.C. text gives the Ring Index name 2-oxazolin-2-yl, the first "2" indicating the position of the double bond. The version given above illustrates the limited British use of $\Delta$, which is permitted in such cases (*J.*, 1950, 3702). [32] Cf. footnote 25.

| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Phthalazine | Phthalazinyl (1- shown) |  |
| Phthalide | Phthalidyl |  |
| Piperidine | *Piperidino |  |
| | *Piperidyl (2- shown) |  |
| Pyran | Pyranyl (2*H*-Pyran-3-yl shown) | |
| Pyrazine | Pyrazinyl | |
| Pyrazolidine | Pyrazolidinyl (3- shown) |  |
| Pyrazoline | Pyrazolinyl ($\Delta^3$-Pyrazolin-1-yl shown) |  |

| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Pyrazole | Pyrazolyl (1- shown) | |
| Pyridazine | Pyridazinyl (3- shown) | |
| Pyridine | *Pyridyl (3- shown) | |
| Pyrimidine | Pyrimidinyl (2- shown) | |
| Pyrrolidine | Pyrrolidinyl (1- shown) |  |
| Pyrroline | Pyrrolinyl ($\Delta^3$-Pyrrolin-1-yl shown) |  |
| Pyrrole | Pyrrolyl (3- shown) | |
| Quinazoline | Quinazolinyl (2- shown) |  |
| Quinoline | *Quinolyl (2- shown) |  |

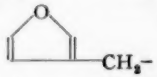
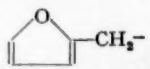
| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| *iso*Quinoline | **iso*Quinolyl (3- shown) | |
| Quinoxaline | Quinoxalinyl (2- shown) |  |
| Quinuclidine | Quinuclidinyl (2- shown) |  |
| Tetrahydroglyoxaline [30] | Tetrahydro-2-glyoxalinyl |  |
| Tetrazole | Tetrazolyl (1- shown) | |
| Thionaphthen [33] | Thionaphthenyl (2- shown) |  |
| Thiazine | Thiazinyl (1 : 3-Thiazin-2-yl shown) |  |

[33] The I.U.P.A.C. text gives the Ring Index name thianaphthene, but when introduced in an extended example this name is not definitive. If named by the thia (oxa-aza) principle, this substance should be called thiaindene; accordingly thionaphthen is used in Chemical Society publications.

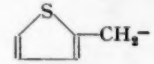
| *Parent compound* | *Radical name* | *Formula* |
|---|---|---|
| Thiazolidine | Thiazolidinyl (3- shown) |  |
| Thiazoline | Thiazolinyl ($\Delta^2$-Thiazolin-2-yl shown) [34] |  |
| Thiazole | Thiazolyl (2- shown) | |
| Thiophen | *Thienyl (2- shown) | |
| Triazine | Triazinyl (1 : 2 : 3-Triazin-4-yl shown) | |
| Triazolidine | Triazolidinyl (1 : 2 : 3-Triazolidin-1-yl shown) |  |
| Triazole | Triazolyl (1 : 2 : 4-Triazol-3-yl shown) | |
| Xanthen | Xanthenyl (9- shown) |  |

[34] Cf. footnote 31.

**Rule 61.1** CYCLIC COMPOUNDS WITH ATTACHMENT ON SIDE-CHAINS

| *Radical name* | *Formula* |
|---|---|
| *Typical examples of numbering* : | |
| 3-Phenylpropyl | $C_6H_5{\cdot}\overset{3}{C}H_2{\cdot}\overset{2}{C}H_2{\cdot}\overset{1}{C}H_2-$ |
| Cinnamyl | $C_6H_5{\cdot}CH{:}\overset{\beta}{C}H{\cdot}\overset{\alpha}{C}H_2-$ |
| *Regularly formed* | |
| Diphenylmethyl, replacing benzhydryl [35] | $(C_6H_5)_2CH-$ |
| 3-Phenylpropyl | $C_6H_5{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2-$ |
| 3-Furylmethyl |  |
| 3 : 4-Dimethoxyphenethyl, replacing homoveratryl [36] | $3:4:1\text{-}(CH_3O)_2C_6H_3{\cdot}CH_2{\cdot}CH_2-$ |
| In the same way other " homo " radicals | |
| *Recommended exceptions* : | |
| Benzyl | $C_6H_5{\cdot}CH_2-$ |
| Cinnamyl | $C_6H_5{\cdot}CH{:}CH{\cdot}CH_2-$ |
| Furfuryl (2- only) |  |
| 3 : 4-Dimethoxybenzyl [36] | $3:4:1\text{-}(CH_3O)_2C_6H_3{\cdot}CH_2-$ |
| 2-Hydroxybenzyl [36] | $o\text{-}HO{\cdot}C_6H_4{\cdot}CH_2-$ |
| 4-Hydroxy-3-methoxybenzyl [36] | $3:4:1\text{-}CH_3O{\cdot}C_6H_3(OH){\cdot}CH_2-$ |
| Methoxybenzyl (4- shown) | $4\text{-}CH_3O{\cdot}C_6H_4{\cdot}CH_2-$ |
| 2-Methylbenzyl | $2\text{-}CH_3{\cdot}C_6H_4{\cdot}CH_2-$ |
| α-Methylbenzyl [37] | $C_6H_5{\cdot}CH(CH_3)-$ |
| 3 : 4-Methylenedioxybenzyl [36] | $3:4:1\text{-}CH_2O_2{:}C_6H_3{\cdot}CH_2-$ |

[35] This change should be noted. [36] Cf. footnote 3.
[37] Replacing the usual British form, 1-phenylethyl.

| *Radical name* | *Formula* |
|---|---|
| Phenethyl [38] | $C_6H_5{\cdot}CH_2{\cdot}CH_2-$ |
| Phenacyl | $C_6H_5{\cdot}CO{\cdot}CH_2-$ |
| *iso*Propylbenzyl (*p*- shown) | $p\text{-}(CH_3)_2CH{\cdot}C_6H_4{\cdot}CH_2-$ |
| Styryl | $C_6H_5{\cdot}CH{:}CH-$ |
| Thenyl (2- shown) |  |
| Trityl [39] | $(C_6H_5)_3C-$ |

**Rule 62.1** BIVALENT AROMATIC RADICALS

| *Radical name* | *Formula* |
|---|---|
| Phenylene (*p*- shown) | $p\text{-}C_6H_4<$ |
| Naphthylene (2 : 7- shown) | $2:7\text{-}C_{10}H_6<$ |
| Anthrylene (2 : 7- shown) | |
| Phenanthrylene (2 : 7- shown) | |
| Acenaphthenylene (1 : 6- shown) [40] | |

[38] This form will be used in Chemical Society publications (cf. note to rule 61.1.), as the radical is introduced in a rule and not merely as an extended example.
[39] It seems strange that I.U.P.A.C. accepted trityl while rejecting the long established benzhydryl. The current Chemical Society practice seems concordant with this situation; it is that trityl is accepted as a prefix in carbohydrate chemistry (owing to much usage), but that other forms such as trityl chloride, tritane, tritanol, etc., are not permitted.
[40] Cf. footnote 25.

**Rule 19** HALOGEN RADICALS [41]

| *Radical name* | *Formula* | *Radical name* | *Formula* |
|---|---|---|---|
| Bromo | Br– | Iodo | I– |
| Chloro | Cl– | Iodoso | OI– |
| Fluoro | F– | Iodoxy | $O_2I$– |

RADICALS CONTAINING OXYGEN
(not covered by rules)

| *Radical name* | *Formula* |
|---|---|
| (1) *R·O–* | |
| Methoxy | $CH_3O$– |
| Ethoxy | $CH_3·CH_2·O$– |
| Propoxy | $CH_3·CH_2·CH_2·O$– |
| *iso*Propoxy | $(CH_3)_2CH·O$– |
| Butoxy | $CH_3·[CH_2]_2·CH_2·O$– |
| *iso*Butoxy | $(CH_3)_2CH·CH_2·O$– |
| *sec.*-Butoxy | $CH_3·CH_2·CH(CH_3)·O$– |
| Pentyloxy [42] | $CH_3·CH_2·CH_2·CH_2·CH_2·O$– |
| *iso*Pentyloxy | $(CH_3)_2CH·CH_2·CH_2·O$– |
| Allyloxy | $CH_2$:$CH·CH_2·O$– |
| Phenoxy | $C_6H_5·O$– |
| Benzyloxy | $C_6H_5·CH_2·O$– |
| Naphthyloxy (2- shown) | 2-$C_{10}H_7·O$– |
| (2) *–O·X·O–* | |
| Methylenedioxy | $–O·CH_2·O$– |
| Ethylenedioxy | $–O·CH_2·CH_2·O$– |
| (3) *R·$CO_2$–* [43] | |
| Formyloxy | $H·CO_2$– |
| Acetoxy | $CH_3·CO_2$– |
| Propionyloxy | $CH_3·CH_2·CO_2$– |
| Benzoyloxy | $C_6H_5·CO_2$– |
| Naphthoyloxy (2- shown) | 2-$C_{10}H_7·CO_2$– |

[41] The halogen radicals should be primarily the concern of the Inorganic Commission of I.U.P.A.C., but are presumably listed here particularly to emphasise that fluoro, not fluo, is desired.

[42] Retention of yl in pentyloxy sets the pattern for higher homologues (cf. also naphthyloxy). The yl is elided only in the eight cases listed.

[43] In accordance with this list, British use of formoxy, propionoxy, and butyroxy, etc., must be abandoned.

(4) *Other radicals containing oxygen* (cf. Rule 52)

| *Radical name* | *Formula* |
|---|---|
| Hydroxy | HO– |
| Carboxy | $–CO_2H$ |
| Carbonyldioxy | $–O·CO·O$– |
| Epoxy | –O– [44] |
| Aldo [45] recommended for use in generic sense as in aldohexose | =O |
| Keto [45] recommended for use in generic sense as in ketohexose | =O |
| Oxo [45] recommended for use in specific sense, as in 3-oxoheptanoic acid | =O |

RADICALS CONTAINING SULPHUR

| *Radical name* | *Formula* |
|---|---|
| (1) *R·S–* | |
| Thio | –S– |
| Mercapto (for unsubstituted radical only) | HS– |
| Methylthio | $CH_3·S$– |
| Ethylthio | $CH_3·CH_2·S$– |
| Benzylthio | $C_6H_5·CH_2·S$– |
| Note : (Phenylthio)acetic acid | $C_6H_5·S·CH_2·CO_2H$ |
| (2) *Other radicals containing sulphur* (cf. Rules 52 and 58.2) | |
| Sulphino | $HO_2S$– |
| Sulpho | $HO_3S$– |
| Thiocarbonyl | –CS– |
| Thiocarbamoyl | $NH_2·CS$– |
| Thioformyl | H·CS– |

[44] Attached to different atoms already united in some other way.

[45] See note to rule 52.

RADICALS CONTAINING NITROGEN

| *Radical name* | *Formula* |
|---|---|
| (1) *CN* | |
| Cyano | NC– |
| *iso*Cyano | CN– |
| Cyanato | NCO– |
| *iso*Cyanato | OCN– |
| Thiocyanato | NCS– |
| *iso*Thiocyanato | SCN– |
| (2) *Amino*, etc. (cf. Rule 52) | |
| Amino | $NH_2$– |
| Imino | NH= |
| Nitrilo | N≡ |
| Acetylimino, replacing acetimido [46] | $CH_3$·CO·N= |
| Benzoylimino, replacing benzimido [46] | $C_6H_5$·CO·N= |
| Phenylimino [47] | $C_6H_5$·N= |
| (3) *Radicals containing oxygen and nitrogen* (cf. Rule 52) | |
| Nitro | $O_2N$– |
| Nitroso | ON– |
| Hydroxyamino [48] | HO·NH– |
| Hydroxyimino, replacing *iso*nitroso [48] | HO·N= |
| *aci*-Nitro, replacing *iso*nitro | HO·N(:O)= |

(4) *Radicals containing more than one nitrogen*

| *Radical name* | *Formula* | *Based on rule* |
|---|---|---|
| Hydrazino | $NH_2$·NH– | 52 |
| Hydrazono | $NH_2$·N= | |
| Hydrazo, to different atoms | –HN·NH– | |
| Hydrazi, to same atom | | |
| Azo | –N:N– | 52 |

[46] Cf. note to rule 32.

[47] This replaces anilo, hitherto current (and convenient) British usage.

[48] These are rational changes from older nomenclature and make for clarity.

| *Radical name* | *Formula* | *Based on rule* |
|---|---|---|
| Diazo |  [49] | 43 |
| Diazonium | N:N⁺– | 43 |
| Azino | =N·N= | |
| Nitramino [50] | $NO_2$·NH– | |
| Nitrosamino [50] | NO·NH– | |
| Nitrosimino [50] | NO·N= | |
| Azoxy | –N:N(→O)– | 52 |
| Phenylazo [51] | $C_6H_5$·N:N– | |
| Azido | $N_3$– | |
| Triazeno | $NH_2$·N:N– | |
| Diazoamino | –N:N·NH– | |
| Phenylenebisazo (*p*- shown) | –N:N·$C_6H_4$·N:N– (*p*) | |
| Semicarbazido | $NH_2$·CO·NH·NH– | |
| Semicarbazono | $NH_2$·CO·NH·N= | |
| Ureylene | –NH·CO·NH– | 36 |

RADICALS CONTAINING OTHER ELEMENTS

| | | |
|---|---|---|
| Au : Auro | Au– | |
| Auri | Au= | |
| Hg : Chloromercuri | ClHg– | 48 |
| Mercuri | –Hg– | 48 |
| Se : Selenino | $HO_2Se$– | |
| Seleninyl | OSe= | |
| Seleno | –Se– | |
| Selenono | $HO_3Se$– | |
| Selenonyl | $O_2Se$= | |
| Selenyl | HSe– | |
| Si : The organosilicon radicals are listed in rule 70.6. | | |
| Sn : Stannyl | $H_3Sn$– | |
| Te : Telluro | –Te– | |

[49] United to same atom.

[50] These accord with the recent British adoption of nitramine and nitrosamine, in preference to nitroamine and nitrosoamine (*J.*, 1950, 3701).

[51] This decides the vexed question of phenylazo *versus* benzeneazo. (N.B. It is additive nomenclature; cf. p. 5062.)

## List of radical names

The purpose of this list of radicals is to provide a convenient check list of recommended names for the more common radicals. The majority of these names are logically derived from I.U.P.A.C. rules and may serve as prototypes for the other members of their respective family or series. Certain other names are included as being preferred to their systematic names because of long established usage or outstanding convenience. Regularly formed compound radical names are not ordinarily included. A few are listed, however, to clarify certain of the recommendations. The absence of a radical name from this list does not necessarily reflect upon its accuracy.

The names in this list are the same as those shown in the list of extended examples [and they are also indexed by formula in the I.U.P.A.C. text].

The rule on which a given name is based is indicated by number while an exception to a rule is indicated by " Ex."

Special recommendations in regard to the use of certain names are indicated as follows :

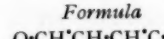
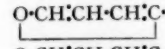
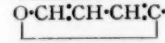
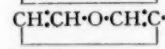
* for unsubstituted radical only. ** for use when substituted. *** an acid radical.

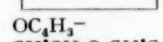
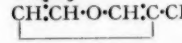
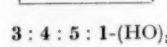
[The appropriate rule and extended examples should be consulted for editorial comment. Ed.]

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Acenaphthenyl | $C_{12}H_9-$ | 59.1 |
| Acenaphthenylene | $-C_{12}H_8-$ | 62.1 |
| Acenaphthenylidene | $C_{12}H_8=$ | 56.1 |
| Acetamido | $CH_3{\cdot}CO{\cdot}NH-$ | 58.6 |
| *acetimido, see* Acetylimino | | |
| Acetimidoyl | $CH_3{\cdot}C(:NH)-$ | 58.8 |
| Acetoacetyl | $CH_3{\cdot}CO{\cdot}CH_2{\cdot}CO-$ | 58.3 Ex |
| Acetonyl | $CH_3{\cdot}CO{\cdot}CH_2-$ | |
| Acetonylidene | $CH_3{\cdot}CO{\cdot}CH=$ | 65.2 |
| Acetyl | $CH_3{\cdot}CO-$ | 58.3 Ex |
| Acetylimino, *replacing acetimido* | $CH_3{\cdot}CO{\cdot}N=$ | |
| Acetoxy | $CH_3{\cdot}CO{\cdot}O-$ | |
| Acridinyl | $NC_{13}H_8-$ | 60.1 |
| Acryloyl | $CH_2{:}CH{\cdot}CO-$ | 58.3 |
| Adipoyl | $-CO{\cdot}[CH_2]_4{\cdot}CO-$ | 58.3 |
| Alanyl | $CH_3{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Aldo (*in generic sense*) | $O=$ | 52 |
| Allyl, *preferred to* 2-*propenyl* | $CH_2{:}CH{\cdot}CH_2-$ | 55.1 Ex |
| Allylidene, *preferred to* 2-*propenylidene* | $CH_2{:}CH{\cdot}CH=$ | 56.1 |
| Allyloxy | $CH_2{:}CH{\cdot}CH_2{\cdot}O-$ | |
| Amidino, *replacing guanyl* | $NH_2{\cdot}C(:NH)-$ | see 58.9 |
| Amino | $NH_2-$ | 52 |
| *amyl, see* Pentyl | | |
| iso*amyl, see iso*Pentyl | | |
| Anilino | $C_6H_5{\cdot}NH-$ | 58.9 |
| Anisidino (*o*-, *m*-, or *p*-) | $CH_3O{\cdot}C_6H_4{\cdot}NH-$ | 58.9 |
| Anisoyl (*o*-, *m*-, or *p*-) | $CH_3O{\cdot}C_6H_4{\cdot}CO-$ | 58.3 |
| Anthraniloyl | $o\text{-}NH_2{\cdot}C_6H_4{\cdot}CO-$ | 58.3 |
| Anthraquinonyl | $(O:)_2C_{14}H_7-$ | see 59.1 |
| Anthryl | $C_{14}H_9-$ | 59.1 Ex |
| Anthrylene | $-C_{14}H_8-$ | 62.1 |
| Antipyrinyl | $OC{\cdot}N(C_6H_5){\cdot}N(CH_3){\cdot}C(CH_3){:}C-$ | 60.1 |
| Arginyl | $NH_2{\cdot}C(:NH){\cdot}NH{\cdot}[CH_2]_3{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Asparaginyl | $NH_2{\cdot}CO{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 Ex |
| Aspartoyl | $-CO{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | 58.3 |
| Aspartyl | $HO_2C{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Atropoyl, *preferred to* 2-*phenylacryloyl* | $C_6H_5{\cdot}C(:CH_2){\cdot}CO-$ | 58.3 |
| Auri | $Au\equiv$ | |
| Auro | $Au-$ | |
| Azelaoyl * | $-CO{\cdot}[CH_2]_7{\cdot}CO-$ | 58.3 |
| Azido | $N_3-$ | |
| Azino | $=N{\cdot}N=$ | |
| Azo | $-N{:}N-$ | 52 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Azoxy | $-N(O)\cdot N-$ | 52 |
| Benzamido | $C_6H_5\cdot CO\cdot NH-$ | 58.6 |
| Benzenesulphinyl *** | $C_6H_5\cdot SO-$ | 58.2 |
| Benzenesulphonamido | $C_6H_5\cdot SO_2\cdot NH-$ | 58.6 |
| Benzenesulphonyl *** | $C_6H_5\cdot SO_2-$ | 58.2 |
| *benzhydryl, see* Diphenylmethyl | | |
| Benzidino | $p\text{-}NH_2\cdot C_6H_4\cdot C_6H_4\cdot NH-$ | 58.9 |
| Benziloyl | $(C_6H_5)_2C(OH)\cdot CO-$ | 58.3 |
| Benziminazolyl | $N_2C_7H_5-$ | 60.1 |
| *benzimido, see* Benzoylimino | | |
| Benzimidoyl | $C_6H_5\cdot C(:NH)-$ | 58.8 |
| Benzofuranyl | $OC_8H_5-$ | 60.1 |
| Benzopyranyl | $OC_9H_7-$ | 60.1 |
| Benzoquinonyl (*o*- or *p*-) | $(O:)_2C_6H_3-$ | see 59.1 |
| Benzoxazinyl | $ONC_8H_6-$ | 60.1 |
| Benzoxazolyl | $ONC_7H_4-$ | 60.1 |
| Benzoyl | $C_6H_5\cdot CO-$ | 58.3 |
| Benzoylimino, *replacing benzimido* | $C_6H_5\cdot CO\cdot N=$ | |
| Benzoyloxy | $C_6H_5\cdot CO\cdot O-$ | |
| Benzyl | $C_6H_5\cdot CH_2-$ | 61.1 Ex |
| Benzylidene | $C_6H_5\cdot CH=$ | 56.1 |
| Benzylidyne | $C_6H_5\cdot C\equiv$ | 56.1 |
| Benzyloxy | $C_6H_5\cdot CH_2\cdot O-$ | |
| Benzylthio | $C_6H_5\cdot CH_2\cdot S-$ | |
| Bromo | $Br-$ | 19 |
| Butadienyl (**1 : 3-** *shown*) | $CH_2{:}CH\cdot CH{:}CH-$ | 55.1 |
| But-1-enyl | $CH_3\cdot CH_2\cdot CH{:}CH-$ | 55.1 |
| But-2-enyl, *replacing crotyl* | $CH_3\cdot CH{:}CH\cdot CH_2-$ | 55.1 |
| But-2-enylene | $-CH_2\cdot CH{:}CH\cdot CH_2-$ | 57.2 |
| Butenylidene (**-2-** *shown*) | $CH_3\cdot CH{:}CH\cdot CH=$ | 56.1 |
| Butenylidyne (**-2-** *shown*) | $CH_3\cdot CH{:}CH\cdot C\equiv$ | 56.1 |
| Butoxy | $CH_3\cdot[CH_2]_2\cdot CH_2\cdot O-$ | Ex |
| *iso*Butoxy * | $(CH_3)_2CH\cdot CH_2\cdot O-$ | Ex |
| *sec.*-Butoxy | $C_2H_5\cdot CH(CH_3)\cdot O-$ | Ex |
| Butyl | $CH_3\cdot[CH_2]_2\cdot CH_2-$ | 54.1 |
| *iso*Butyl * | $(CH_3)_2CH\cdot CH_2-$ | 54.2 |
| *sec.*-Butyl * | $C_2H_5\cdot CH(CH_3)-$ | 54.3 Ex |
| *tert.*-Butyl * | $(CH_3)_3C-$ | 54.3 Ex |
| *cyclo*Butyl | $C_4H_7-$ | 54.4 |
| 1-Butylbut-2-enyl | $CH_3\cdot CH{:}CH\cdot CHBu^n-$ | 55.1 |
| Butylidene | $CH_3\cdot CH_2\cdot CH_2\cdot CH=$ | 56.1 |
| *iso*Butylidene * | $(CH_3)_2CH\cdot CH=$ | 56.1 |
| Butylidyne | $CH_3\cdot[CH_2]_2\cdot C\equiv$ | 56.1 |
| *iso*Butylidyne * | $(CH_3)_2CH\cdot C\equiv$ | 56.1 |
| Butyryl | $CH_3\cdot CH_2\cdot CH_2\cdot CO-$ | 58.3 |
| *iso*Butyryl | $(CH_3)_2CH\cdot CO-$ | 58.3 |
| Cacodyl * | $(CH_3)_2As-$ | 34 |
| Camphoroyl | $C_{10}H_{14}O_2-$ | 58.3 |
| *caprinoyl, see* Decanoyl | | |
| *caproyl, see* Hexanoyl | $CH_3\cdot[CH_2]_4\cdot CO-$ | 58.3 |
| *capryl, see* Decanoyl | | |
| *capryloyl, see* Octanoyl | | |
| *caprylyl, see* Octanoyl | | |
| Carbamoyl | $NH_2\cdot CO-$ | 58.4 |
| Carbazolyl | $NC_{12}H_8-$ | 60.1 |
| *carbethoxy, see* Ethoxycarbonyl | | |
| *carbomethoxy, see* Methoxycarbonyl | | |
| Carbonyl | $OC=$ | 58.1 |
| Carbonyldioxy | $OC\langle{}^{O-}_{O-}$ | |
| Carboxy | $HO_2C-$ | 52 |
| *cetyl, see* Hexadecyl | | |
| Chloro | $Cl-$ | 19 |
| Chloromercuri | $ClHg-$ | 48 |
| Chrysenyl | $C_{18}H_{11}-$ | 59.1 |
| Cinnamoyl | $C_6H_5\cdot CH{:}CH\cdot CO-$ | 58.3 |
| Cinnamyl | $C_6H_5\cdot CH{:}CH\cdot CH_2-$ | 61.1 Ex |
| Cinnamylidene | $C_6H_5\cdot CH{:}CH\cdot CH=$ | 56.1 |
| Citraconoyl | $-CO\cdot C(CH_3){:}CH\cdot CO-$ (*cis*) | 58.3 |
| Crotonoyl, *preferred to* trans-*but-2-enoyl* | $CH_3\cdot CH{:}CH\cdot CO-$ | 58.3 |
| *crotyl, see* But-2-enyl | | |
| Cumenyl (*o*-, *m*-, or *p*-) | $(CH_3)_2CH\cdot C_6H_4-$ | 59.1 |
| Cumidino | $p\text{-}(CH_3)_2CH\cdot C_6H_4\cdot NH-$ | 58.9 |
| pseudo*cumidino, see* **2 : 4 : 5**-Trimethylanilino | | |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| *cumoyl, see p-iso*Propylbenzoyl | | |
| Cyanato | N⋮C·O– | |
| *iso*Cyanato | O⋮C⋮N– | |
| Cyano | N⋮C– | |
| *iso*Cyano | C⋮N– | |
| Cysteinyl | HS·$CH_2$·CH($NH_2$)·CO– | 58.5 Ex |
| Cystyl | –CO·CH($NH_2$)·$CH_2$·S·S·$CH_2$·CH($NH_2$)·CO– | 58.5 |
| Decanedioyl ** | –CO·$[CH_2]_8$·CO– | 58.3 |
| Decanoyl, *replacing caprinoyl and capryl* | $CH_3$·$[CH_2]_8$·CO– | 58.3 |
| Decyl | $CH_3$·$[CH_2]_8$·$CH_2$– | 54.1 |
| Diazo | –N⋮N– | 43 |
| Diazoamino | –N⋮N·NH– | 43 |
| Diazonium | N⋮$N^+$– | 43 |
| Dihydroglyoxalinyl | $N_2C_3H_5$– | 60.1 |
| **3** : 4-Dimethoxybenzyl | 3 : 4 : 1-$(CH_3O)_2C_6H_3$·$CH_2$– | 61.1 Ex |
| **3** : 4-Dimethoxyphenethyl, *replacing homoveratryl* | 3 : 4 : 1-$(CH_3O)_2C_6H_3$·$CH_2$·$CH_2$– | 61.1 |
| **3** : 4-Dimethoxyphenylacetyl, *replacing homoveratroyl* | 3 : 4 : 1-$(CH_3O)_2C_6H_3$·$CH_2$·CO– | 58.3 Ex |
| Dimethylamino | $(CH_3)_2$N– | 58.9 |
| Dimethylbenzoyl, *replacing xyloyl* | $(CH_3)_2C_6H_3$·CO– | 58.3 |
| Diphenylmethyl, *replacing benzhydryl* | $(C_6H_5)_2$CH– | 61.1 |
| Diphenylyl | $C_6H_5$·$C_6H_4$– | 59.1 Ex |
| Disilanoxy | $H_3Si$·$SiH_2$·O– | 70.6 |
| Disilanyl | $H_3Si$·$SiH_2$– | 70.6 |
| Disilanylamino | $H_3Si$·$SiH_2$·NH– | 70.6 |
| Disilanylene | –$SiH_2$·$SiH_2$– | 70.6 |
| Disilanylthio | $H_3Si$·$SiH_2$·S– | 70.6 |
| Disilazanoxy | $H_3Si$·NH·$SiH_2$·O– | 70.6 |
| Disilazanyl | $H_3Si$·NH·$SiH_2$– | 70.6 |
| Disilazanylamino | $H_3Si$·NH·$SiH_2$·NH– | 70.6 |
| Disiloxanoxy | $H_3Si$·O·$SiH_2$·O– | 70.6 |
| Disiloxanyl | $H_3Si$·O·$SiH_2$– | 70.6 |
| Disiloxanylamino | $H_3Si$·O·$SiH_2$·NH– | 70.6 |
| Disiloxanylthio | $H_3Si$·O·$SiH_2$·S– | 70.6 |
| Disilthianoxy | $H_3Si$·S·$SiH_2$·O– | 70.6 |
| Disilthianyl | $H_3Si$·S·$SiH_2$– | 70.6 |
| Disilthianylthio | $H_3Si$·S·$SiH_2$·S– | 70.6 |
| Disilyldisilanyl | $(H_3Si)_3Si$– | 70.6 |
| Docosyl | $CH_3$·$[CH_2]_{20}$·$CH_2$– | 54.1 |
| Dodecanoyl ** | $CH_3$·$[CH_2]_{10}$·CO– | 58.3 |
| Dodecyl | $CH_3$·$[CH_2]_{10}$·$CH_2$– | 54.1 |
| Dotriacontyl | $CH_3$·$[CH_2]_{30}$·$CH_2$– | 54.1 |
| Eicosyl | $CH_3$·$[CH_2]_{18}$·$CH_2$– | 54.1 |
| *enanthoyl, see* Heptanoyl | | |
| Epoxy (*to different atoms already united in some other way*) | –O– | 24 |
| *ethenyl, see* Vinyl | | |
| *ethenylene, see* Vinylene | | |
| *ethenylidene, see* Vinylidene | | |
| Ethoxalyl | $C_2H_5O_2C$·CO– | 58.3 Ex |
| Ethoxy | $C_2H_5O$– | Ex |
| Ethoxycarbonyl, *replacing carbethoxy* | $C_2H_5O_2C$– | 58.3 |
| Ethyl | $CH_3$·$CH_2$– | 54.1 |
| Ethylamino | $C_2H_5$·NH– | 58.9 |
| Ethylene | –$CH_2$·$CH_2$– | 57.1 |
| Ethylenedioxy | –O·$CH_2$·$CH_2$·O– | |
| Ethylidene | $CH_3$·CH= | 56.1 |
| Ethylidyne | $CH_3$·C≡ | 56.1 |
| Ethylthio | $CH_3$·$CH_2$·S– | 25 |
| Ethynyl | CH⋮C– | 55.1 |
| Ethynylene | –C⋮C– | 57.2 |
| Fluorenyl | $C_{13}H_9$– | 59.1 |
| Fluorenylidene | $C_{13}H_8$= | 56.1 |
| Fluoro | F– | 19 |
| Formamido | OHC·NH– | 58.6 |
| Formyl | OHC– | 58.3 Ex |
| Formyloxy | HCO·O– | |
| Fumaroyl | –CO·CH⋮CH·CO– (*trans-*) | 58.3 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| **Furfuryl** (**2-** *only*) |  | 61.1 Ex |
| **Furfurylidene** (**2-** *only*) |  | 56.2 |
| **Furoyl** (**3-** *shown*) |  | 58.3 |
| **Furyl** | $OC_4H_3-$ | 60.1 Ex |
| **3-Furylmethyl** |  | 61.1 |
| **Galloyl** | **3 : 4 : 5 : 1-**$(HO)_3C_6H_2\cdot CO-$ | 58.3 |
| **Geranyl,*** *preferred to* **3 : 7-***dimethylocta*-trans-**2 : 6**(*or* **7**)-*dienyl* | $C_{10}H_{17}-$ | 55.1 Ex |
| **Glutaminyl** | $NH_2\cdot CO\cdot CH_2\cdot CH_2\cdot CH(NH_2)\cdot CO-$ | 58.5 Ex |
| **Glutamoyl** | $-CO\cdot CH_2\cdot CH_2\cdot CH(NH_2)\cdot CO-$ | 58.3 |
| **Glutamyl** | $HO_2C\cdot[CH_2]_2\cdot CH(NH_2)\cdot CO-$ | 58.5 |
| **Glutaryl** | $-CO\cdot[CH_2]_3\cdot CO-$ | 58.3 |
| **Glyceroyl** | $HO\cdot CH_2\cdot CH(OH)\cdot CO-$ | 58.3 |
| **Glycolloyl** | $HO\cdot CH_2\cdot CO-$ | 58.3 |
| **Glycyl** | $NH_2\cdot CH_2\cdot CO-$ | 58.5 |
| **Glyoxalinyl** | $N_2C_3H_3-$ | |
| **Glyoxyloyl** | $OHC\cdot CO-$ | 58.3 |
| **Guanidino** | $NH_2\cdot C(:NH)\cdot NH-$ | 58.9 |
| *guanyl, see* **Amidino** | | |
| *hendecyl, see* **Undecyl** | | |
| **Heneicosyl** | $CH_3\cdot[CH_2]_{19}\cdot CH_2-$ | 54.1 |
| **Hentriacontyl** | $CH_3\cdot[CH_2]_{29}\cdot CH_2-$ | 54.1 |
| **Heptacosyl** | $CH_3\cdot[CH_2]_{25}\cdot CH_2-$ | 54.1 |
| **Heptadecanoyl** | $CH_3\cdot[CH_2]_{15}\cdot CO-$ | 58.3 |
| **Heptadecyl** | $CH_3\cdot[CH_2]_{15}\cdot CH_2-$ | 54.1 |
| **Heptanamido,** *preferred to hexanecarbonamido* | $CH_3\cdot[CH_2]_5\cdot CO\cdot NH-$ | 58.6 |
| **Heptanedioyl** ** | $-CO\cdot[CH_2]_5\cdot CO-$ | 58.3 |
| **Heptanoyl,** *replacing enanthoyl and œnanthyl* | $CH_3\cdot[CH_2]_5\cdot CO-$ | 58.3 |
| **Heptyl** | $CH_3\cdot[CH_2]_5\cdot CH_2-$ | 54.1 |
| *cyclo***Heptyl** | $C_7H_{13}-$ | 54.4 |
| **Hexacontyl** | $CH_3\cdot[CH_2]_{58}\cdot CH_2-$ | 54.1 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| **Hexacosyl** | $CH_3\cdot[CH_2]_{24}\cdot CH_2-$ | 54.1 |
| **Hexadecanoyl** ** | $CH_3\cdot[CH_2]_{14}\cdot CO-$ | 58.3 |
| **Hexadecyl,** *replacing cetyl* | $CH_3\cdot[CH_2]_{14}\cdot CH_2-$ | 54.1 |
| *cyclo***Hexadienyl** (**-2 : 4-** *shown*) |  | 55.1 |
| *cyclo***Hexadienylene** | $-C_6H_6-$ | 57.3 |
| *cyclo***Hexadienylidene** (**-2 : 5-** *shown*) |  | 56.1 |
| **Hexamethylene** | $-CH_2\cdot[CH_2]_4\cdot CH_2-$ | 57.1 |
| *hexanecarbonamido, see* **Heptanamido** | | |
| **Hexanedioyl** ** | $-CO\cdot[CH_2]_4\cdot CO-$ | 58.3 |
| *cyclo***Hexasilanyl** |  | 70.6 |
| *cyclo***Hexenyl** | $C_6H_9-$ | 55.1 |
| *cyclo***Hexenylene** | $-C_6H_8-$ | 57.3 |
| *cyclo***Hexenylidene** (**-2-** *shown*) |  | 56.1 |
| **Hexyl** | $CH_3\cdot[CH_2]_4\cdot CH_2-$ | 54.1 |
| *iso***Hexyl** | $(CH_3)_2CH\cdot[CH_2]_2\cdot CH_2-$ | 54.2 |
| *cyclo***Hexyl** | $C_6H_{11}-$ | 54.4 |
| *cyclo***Hexylene** | $-C_6H_{10}-$ | 57.3 |
| **Hexylidene** | $CH_3\cdot[CH_2]_4\cdot CH=$ | 56.1 |
| *iso***Hexylidene** * | $(CH_3)_2CH\cdot[CH_2]_2\cdot CH=$ | 56.1 |
| *cyclo***Hexylidene** |  | 56.1 |
| **Hexylidyne** | $CH_3\cdot[CH_2]_4\cdot C\equiv$ | 56.1 |
| *iso***Hexylidyne** * | $(CH_3)_2CH\cdot[CH_2]_2\cdot C\equiv$ | 56.1 |
| **Hippuroyl** | $C_6H_5\cdot CO\cdot NH\cdot CH_2\cdot CO-$ | 58.3 |
| **Histidyl** | $N_2C_3H_3\cdot CH_2\cdot CH(NH_2)\cdot CO-$ | 58.5 |
| *homoveratroyl, see* **3 : 4-Dimethoxyphenylacetyl** | | |
| *homoveratryl, see* **3 : 4-Dimethoxyphenethyl** | | |
| **Hydratropoyl,** *preferred to* **2-***phenylpropionyl* | $C_6H_5\cdot CH(CH_3)\cdot CO-$ | 58.3 |
| **Hydrazi** | $-NH\cdot NH-$ (*to same atom*) | |
| **Hydrazino** | $NH_2\cdot NH-$ | 52 |
| **Hydrazo** | $-NH\cdot NH-$ (*to different atoms*) | |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Hydrazono | $NH_2{\cdot}N{=}$ | |
| Hydroxy | $HO{-}$ | 52 |
| Hydroxyamino | $HO{\cdot}NH{-}$ | |
| 2-Hydroxybenzyl | $o\text{-}HO{\cdot}C_6H_4{\cdot}CH_2{-}$ | 61.1 Ex |
| 2-Hydroxybenzylidene | $o\text{-}NO{\cdot}C_6H_4{\cdot}CH{=}$ | 56.2 |
| 4-Hydroxy-3-methoxybenzyl | $3:4:1\text{-}CH_3O{\cdot}(HO)C_6H_3{\cdot}CH_2{-}$ | 61.1 Ex |
| 4-Hydroxy-3-methoxybenzylidene | $3:4:1\text{-}CH_3O{\cdot}(HO)C_6H_3{\cdot}CH{=}$ | 56.2 |
| Hydroxyimino, *replacing* iso*nitroso* | $HO{\cdot}N{=}$ | |
| Imino | $HN{=}$ | |
| Indanyl | $C_9H_9{-}$ | see 59.1 |
| Indazolyl | $N_2C_7H_5{-}$ | 60.1 |
| Indenyl | $C_9H_7{-}$ | 59.1 |
| Indolinyl | $NC_8H_8{-}$ | 60.1 |
| *iso*Indolinyl | $NC_8H_8{-}$ | 60.1 |
| Indolinylidene (3- *shown*) | $CH_2{\cdot}NH{\cdot}C_6H_4{\cdot}C{=}$ | 56.2 |
| Indolyl | $NC_8H_6{-}$ | 60.1 |
| *iso*Indolyl | $NC_8H_6{-}$ | 60.1 |
| *pseudo*Indolyl | $NC_8H_6{-}$ | 60.1 |
| Iodo | $I{-}$ | 19 |
| Iodoso | $OI{-}$ | |
| Iodoxy | $O_2I{-}$ | |
| Keto (*in generic sense*) | $O{=}$ | 52 |
| Lactoyl | $CH_3{\cdot}CH(OH){\cdot}CO{-}$ | 58.3 |
| Lauroyl * | $CH_3{\cdot}[CH_2]_{10}{\cdot}CO{-}$ | 58.3 |
| Leucyl | $(CH_3)_2CH{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| *iso*Leucyl | $C_2H_5{\cdot}CH(CH_3){\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| *nor*Leucyl | $CH_3{\cdot}[CH_2]_3{\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| Linalyl * | $C_{10}H_{17}{-}$ | 55.1 Ex |
| Lysyl | $NH_2{\cdot}[CH_2]_4{\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| Maleoyl | $-CO{\cdot}CH{:}CH{\cdot}CO{-}$ (*cis-*) | 58.3 |
| Malonyl | $-CO{\cdot}CH_2{\cdot}CO{-}$ | 58.3 |
| Maloyl | $-CO{\cdot}CH(OH){\cdot}CH_2{\cdot}CO{-}$ | 58.3 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Mercuri | $-Hg-$ | 48 |
| Mesaconoyl | $-CO{\cdot}C(CH_3){:}CH{\cdot}CO{-}$ (*trans-*) | 58.3 |
| *mesidino, see* 2 : 4 : 6-Trimethylanilino | | |
| Mesityl | $2:4:6:1\text{-}(CH_3)_3C_6H_2{-}$ | 59.1 Ex |
| Mesoxalyl | $-CO{\cdot}CO{\cdot}CO{-}$ | 58.3 Ex |
| Methacryloyl, *preferred to* 2-*methylacryloyl* | $CH_2{:}C(CH_3){\cdot}CO{-}$ | 58.3 |
| *methallyl, see* Methylallyl | | |
| Methionyl | $CH_3S{\cdot}CH_2{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| Methoxalyl | $CH_3O_2C{\cdot}CO{-}$ | 58.3 Ex |
| Methoxy | $CH_3O{-}$ | Ex |
| Methoxybenzyl | $CH_3O{\cdot}C_6H_4{\cdot}CH_2{-}$ | 61.1 Ex |
| Methoxycarbonyl, *replacing carbomethoxy* | $CH_3O_2C{-}$ | 58.1 |
| Methoxyphenyl | $CH_3O{\cdot}C_6H_4{-}$ | 59.1 Ex |
| Methyl | $CH_3{-}$ | 54.1 |
| 2-*methylacryloyl, see* Methacryloyl | | |
| Methylallyl, *preferred to methallyl* | $CH_2{:}C(CH_3){\cdot}CH_2{-}$ | 55.1 Ex |
| α-Methylbenzyl | $C_6H_5{\cdot}CH(CH_3){-}$ | 61.1 Ex |
| 2-Methylbenzyl | $o\text{-}CH_3{\cdot}C_6H_4{\cdot}CH_2{-}$ | 61.1 Ex |
| Methylene | $CH_2{=}$ | 56.1 Ex |
| Methylenedioxy | $-O{\cdot}CH_2{\cdot}O{-}$ | |
| 3 : 4-Methylenedioxybenzyl | $3:4:1\text{-}CH_2O_2{:}C_6H_3{\cdot}CH_2{-}$ | 61.1 Ex |
| 3 : 4-Methylenedioxybenzylidene | $3:4:1\text{-}CH_2O_2{:}C_6H_3{\cdot}CH{=}$ | 56.2 |
| 5-Methylhexyl | $(CH_3)_2CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{-}$ | 54.2 |
| Methylidyne | $CH{\equiv}$ | 56.1 |
| 1-Methylpentyl | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){-}$ | 54.3 |
| 2-Methylpentyl | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){\cdot}CH_2{-}$ | 54.3 |
| 2-Methylpentylidene | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){\cdot}CH{=}$ | 56.1 |
| 2-Methylpentylidyne | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CH(CH_3){\cdot}C{\equiv}$ | 56.1 |
| Methylthio | $CH_3S{-}$ | 25 |
| 1-*methylvinyl, see iso*Propenyl | | |
| Morpholino (4-*position only*) | $CH_2{\cdot}CH_2{\cdot}O{\cdot}CH_2{\cdot}CH_2{\cdot}N{-}$ | 60.1 Ex |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Morpholinyl (3- *shown*) | NH·$CH_2$·$CH_2$·O·$CH_2$·CH− | 60.1 |
| Myristoyl • | $CH_3$·$[CH_2]_{12}$·CO− | 58.3 |
| Naphthoyl | $C_{10}H_7$·CO− | 58.3 |
| Naphthoyloxy | $C_{10}H_7$·CO·O− | |
| Naphthyl | $C_{10}H_7$− | 59.1 Ex |
| Naphthylene | −$C_{10}H_6$− | 62.1 |
| Naphthylmethylene | $C_{10}H_7$·CH= | 56.1 |
| Naphthylmethylidyne | $C_{10}H_7$·C≡ | 56.1 |
| Naphthyloxy | $C_{10}H_7$·O− | |
| Neryl,• *preferred to* 3 : 7-*dimethylocta*-cis-2 : 6(or 7)-*dienyl* | $C_{10}H_{17}$− | 55.1 Ex |
| Nitramino | $O_2N$·NH− | |
| Nitrilo | N≡ | |
| Nitro | $O_2N$− | 41 |
| *aci*-Nitro, *replacing* iso*nitro* | HO·(O·)N= | |
| iso*nitro*, *see aci*-Nitro | | |
| Nitrosamino | ON·NH− | |
| Nitrosimino | ON·N= | |
| Nitroso | ON− | 52 |
| iso*nitroso*, *see* Hydroxyimino | | |
| Nonacosyl | $CH_3$·$[CH_2]_{27}$·$CH_2$− | 54.1 |
| Nonadecyl | $CH_3$·$[CH_2]_{17}$·$CH_2$− | 54.1 |
| Nonanedioyl •• | −CO·$[CH_2]_7$·CO− | 58.3 |
| Nonanoyl, *replacing pelargonoyl and pelargonyl* | $CH_3$·$[CH_2]_7$·CO− | 58.3 |
| Nonyl | $CH_3$·$[CH_2]_7$·$CH_2$− | 54.1 |
| Octacosyl | $CH_3$·$[CH_2]_{26}$·$CH_2$− | 54.1 |
| Octadecanoyl •• | $CH_3$·$[CH_2]_{16}$·CO− | 58.3 |
| cis-*octadec*-9-*enoyl*, *see* Oleoyl | | |
| Octadecyl | $CH_3$·$[CH_2]_{16}$·$CH_2$− | 54.1 |
| Octanedioyl •• | −CO·$[CH_2]_6$·CO− | 58.3 |
| Octanoyl, *replacing caprylyl and caprylyl* | $CH_3$·$[CH_2]_6$·CO− | 58.3 |
| Octyl | $CH_3$·$[CH_2]_6$·$CH_2$− | 54.1 |
| *œnanthyl*, *see* Heptanoyl | | |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Oleoyl, *preferred to* cis-*octadec*-9-*enoyl* | $CH_3$·$[CH_2]_7$·CH:CH·$[CH_2]_7$·CO− | 58.3 |
| Ornithyl | $NH_2$·$[CH_2]_3$·CH($NH_2$)·CO− | 58.5 |
| Oxalyl | −CO·CO− | 58.3 Ex |
| Oxamoyl | $NH_2$·CO·CO− | 58.4 |
| Oxazinyl | $ONC_4H_4$− | 60.1 |
| Oxazolidinyl | $ONC_3H_6$− | 60.1 |
| Oxazolinyl | $ONC_3H_4$− | 60.1 |
| Oxazolyl | $ONC_3H_2$− | 60.1 |
| *iso*Oxazolyl | $ONC_3H_2$− | 60.1 |
| Oxo (*in specific sense*) | O= | 52 |
| Palmitoyl • | $CH_3$·$[CH_2]_{14}$·CO− | 58.3 |
| *pelargonoyl*, *see* Nonanoyl | | |
| *pelargonyl*, *see* Nonanoyl | | |
| Pentacontyl | $CH_3$·$[CH_2]_{48}$·$CH_2$− | 54.1 |
| Pentacosyl | $CH_3$·$[CH_2]_{23}$·$CH_2$− | 54.1 |
| Pentadecanoyl | $CH_3$·$[CH_2]_{13}$·CO− | 58.3 |
| Pentadecyl | $CH_3$·$[CH_2]_{13}$·$CH_2$− | 54.1 |
| *cyclo*Pentadienyl | $C_5H_5$− | 55.1 |
| *cyclo*Pentadienylidene | CH:CH·CH:CH·C= | 56.1 |
| Pentamethylene | −$CH_2$·$[CH_2]_3$·$CH_2$− | 57.1 |
| Pentazolyl | N:N·N:N·N− | 60.1 |
| Pentenyl (2- *shown*) | $CH_3$·$CH_2$·CH:CH·$CH_2$− | 55.1 |
| *cyclo*Pentenyl | $C_5H_7$− | 55.1 |
| *cyclo*Pentenylidene (-2- *shown*) | $CH_2$·$CH_2$·CH:CH·C= | 56.1 |
| Pentyl, *replacing amyl* | $CH_3$·$[CH_2]_3$·$CH_2$− | 54.1 |
| *neo*Pentyl | $(CH_3)_3C$·$CH_2$− | 54.3 Ex |
| *iso*Pentyl,• *replacing* iso*amyl* | $(CH_3)_2$CH·$CH_2$·$CH_2$− | 54.2 |
| *cyclo*Pentyl | $C_5H_9$− | 54.4 |
| *cyclo*Pentylene | −$C_5H_8$− | 57.3 |
| Pentylidene | $CH_3$·$[CH_2]_3$·CH= | 56.1 |
| *iso*Pentylidene • | $(CH_3)_2$CH·$CH_2$·CH= | 56.1 |
| *cyclo*Pentylidene | $CH_2$·$CH_2$·$CH_2$·$CH_2$·C= | 56.1 |
| Pentylidyne | $CH_3$·$[CH_2]_3$·C≡ | 56.1 |

| Radical name | Formula | Based on rule no. |
|---|---|---|
| *iso*Pentylidyne * | $(CH_3)_2CH{\cdot}CH_2{\cdot}C{\equiv}$ | 56.1 |
| Pentyloxy | $CH_3{\cdot}[CH_2]_3{\cdot}CH_2{\cdot}O{-}$ | |
| *iso*Pentyloxy * | $(CH_3)_2CH{\cdot}CH_2{\cdot}CH_2{\cdot}O{-}$ | |
| Perimidinyl | $N_2C_{11}H_7{-}$ | 60.1 |
| Phenacyl | $C_6H_5{\cdot}CO{\cdot}CH_2{-}$ | 61.1 Ex |
| Phenacylidene | $C_6H_5{\cdot}CO{\cdot}CH{=}$ | 56.2 |
| Phenanthridinyl | $NC_{13}H_8{-}$ | 60.1 |
| Phenanthryl | $C_{14}H_9{-}$ | 59.1 Ex |
| Phenanthrylene | $-C_{14}H_8{-}$ | 62.1 |
| Phenazinyl | $N_2C_{12}H_7{-}$ | 60.1 |
| Phenethyl | $C_6H_5{\cdot}CH_2{\cdot}CH_2{-}$ | 61.1 Ex |
| Phenetidino (*o*-, *m*-, or *p*-) | $C_2H_5O{\cdot}C_6H_4{\cdot}NH{-}$ | 58.9 |
| Phenoxy | $C_6H_5O{-}$ | Ex |
| Phenyl | $C_6H_5{-}$ | 59.1 Ex |
| Phenylacetyl | $C_6H_5{\cdot}CH_2{\cdot}CO{-}$ | 58.3 Ex |
| 2-*phenylacryloyl*, *see* Atropoyl | | |
| Phenylazo | $C_6H_5{\cdot}N{:}N{-}$ | |
| Phenylcarbamoyl | $C_6H_5{\cdot}NH{\cdot}CO{-}$ | 58.4 |
| Phenylene | $-C_6H_4{-}$ | 62.1 |
| Phenylenebisazo | $-N{:}N{\cdot}C_6H_4{\cdot}N{:}N{-}$ | |
| Phenylimino | $C_6H_5{\cdot}N{=}$ | |
| 2-*phenylpropionyl*, *see* Hydratropoyl | | |
| 3-Phenylpropyl | $C_6H_5{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{-}$ | 61.1 |
| Phenylsulphamoyl | $C_6H_5{\cdot}NH{\cdot}SO_2{-}$ | 58.4 |
| Phenylsulphinyl | $C_6H_5{\cdot}SO{-}$ | 58.2 |
| Phenylsulphonyl | $C_6H_5{\cdot}SO_2{-}$ | 58.2 |
| 3-Phenylureido | $C_6H_5{\cdot}NH{\cdot}CO{\cdot}NH{-}$ | 58.6 Ex |
| Phthalamoyl | $NH_2{\cdot}CO{\cdot}C_6H_4{\cdot}CO{-}$ (*o*-) | 58.4 |
| Phthalazinyl | $N_2C_8H_5{-}$ | 60.1 |
| Phthalidyl | $C_6H_4{\cdot}CO{\cdot}O{\cdot}CH{-}$ | 60.1 |
| Phthalidylidene | $C_6H_4{\cdot}CO{\cdot}O{\cdot}C{=}$ | 56.2 |
| Phthalimido | $CO{\cdot}C_6H_4{\cdot}CO{\cdot}N{-}$ | 58.7 |
| Phthaloyl | $-CO{\cdot}C_6H_4{\cdot}CO{-}$ (*o*-) | 58.3 |
| *iso*Phthaloyl | $-CO{\cdot}C_6H_4{\cdot}CO{-}$ (*m*-) | 58.3 |

| Radical name | Formula | Based on rule no. |
|---|---|---|
| Phytyl,* *preferred to* 3 : 7 : 11 : 15-*tetramethylhexadec-2-enyl* | $C_{20}H_{39}{-}$ | 55.1 Ex |
| Pimeloyl * | $-CO{\cdot}[CH_2]_5{\cdot}CO{-}$ | 58.3 |
| Piperidino (1-*position only*) | $C_5H_{10}N{-}$ | 60.1 Ex |
| Piperidyl | $NC_5H_{10}{-}$ | 60.1 Ex |
| Piperidylidene | $NC_5H_9{=}$ | 56.2 |
| Piperonyloyl | 3 : 4 : 1-$CH_2O_2{:}C_6H_3{\cdot}CO{-}$ | 58.3 |
| Pivaloyl | $(CH_3)_3C{\cdot}CO{-}$ | 58.3 |
| Prolyl | $NH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH{\cdot}CO{-}$ | 58.5 |
| Propanetricarbonyl (1 : 2 : 3- *shown*) | $-CO{\cdot}CH_2{\cdot}CH(CO{-}){\cdot}CH_2{\cdot}CO{-}$ | 58.1 |
| *propargyl*, *see* Prop-2-ynyl | | |
| Propenyl (= Prop-1-enyl) | $CH_3{\cdot}CH{:}CH{-}$ | 55.1 |
| *prop*-2-*enyl*, *see* Allyl | | |
| *iso*Propenyl,* *preferred to* 1-*methylvinyl* | $CH_2{:}C(CH_3){-}$ | 55.1 |
| Propenylene | $-CH_2{\cdot}CH{:}CH{-}$ | 57·2 |
| *prop*-2-*enylidene*, *see* Allylidene | | |
| Propioloyl | $CH{\equiv}C{\cdot}CO{-}$ | 58.3 |
| Propionamido | $CH_3{\cdot}CH_2{\cdot}CO{\cdot}NH{-}$ | 58.6 |
| Propionyl | $CH_3{\cdot}CH_2{\cdot}CO{-}$ | 58.3 |
| Propionyloxy | $CH_3{\cdot}CH_2{\cdot}CO{\cdot}O{-}$ | |
| Propoxy | $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}O{-}$ | Ex |
| *iso*Propoxy * | $(CH_3)_2CH{\cdot}O{-}$ | Ex |
| Propyl | $CH_3{\cdot}CH_2{\cdot}CH_2{-}$ | 54.1 |
| *cyclo*Propyl | $C_3H_5{-}$ | 54.4 |
| *iso*Propyl,* *replacing* sec.-*propyl* | $(CH_3)_2CH{-}$ | 54.2 |
| sec.-*propyl*, *see iso*Propyl | | |
| *p*-*iso*Propylbenzoyl, *replacing cumoyl* | $p$-$(CH_3)_2CH{\cdot}C_6H_4{\cdot}CO{-}$ | 58.3 |
| *iso*Propylbenzyl | $(CH_3)_2CH{\cdot}C_6H_4{\cdot}CH_2{-}$ | 61.1 Ex |
| *iso*Propylbenzylidene | $(CH_3)_2CH{\cdot}C_6H_4{\cdot}CH{=}$ | 56.1 |
| Propylene | $-CH(CH_3){\cdot}CH_2{-}$ | 57.1 Ex |
| Propylidene | $CH_3{\cdot}CH_2{\cdot}CH{=}$ | 56.1 |
| *iso*Propylidene * | $(CH_3)_2C{=}$ | 56.1 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Propylidyne | $CH_3{\cdot}CH_2{\cdot}C{\equiv}$ | 56.1 |
| Prop-1-ynyl | $CH_3{\cdot}C{\vdots}C{-}$ | 55.1 |
| Prop-2-ynyl, *replacing propargyl* | $CH{\vdots}C{\cdot}CH_2{-}$ | 55.1 |
| Protocatechuoyl | $3:4:1\text{-}(HO)_2C_6H_3{\cdot}CO{-}$ | 58.3 |
| Pyranyl | $OC_5H_5{-}$ | 60.1 |
| Pyrazinyl | $N_2C_4H_3{-}$ | 60.1 |
| Pyrazolidinyl | $N_2C_3H_7{-}$ | 60.1 |
| Pyrazolinyl | $N_2C_3H_5{-}$ | 60.1 |
| Pyrazolyl | $N_2C_3H_3{-}$ | 60.1 |
| Pyrenyl | $C_{16}H_9{-}$ | 59.1 |
| Pyridazinyl | $N_2C_4H_3{-}$ | 60.1 |
| Pyridyl | $NC_5H_4{-}$ | 60.1 Ex |
| Pyrimidinyl | $N_2C_4H_3{-}$ | 60.1 |
| Pyrrolidinyl | $NC_4H_8{-}$ | 60.1 |
| Pyrrolinyl | $NC_4H_6{-}$ | 60.1 |
| Pyrrolyl | $NC_4H_4{-}$ | 60.1 |
| Pyruvoyl | $CH_3{\cdot}CO{\cdot}CO{-}$ | 58.3 |
| Quinazolinyl | $N_2C_8H_5{-}$ | 60.1 |
| Quinolyl | $NC_9H_6{-}$ | 60.1 Ex |
| *iso*Quinolyl | $NC_9H_6{-}$ | 60.1 Ex |
| Quinoxalinyl | $N_2C_8H_5{-}$ | 60.1 |
| Quinuclidinyl | $NC_7H_{12}{-}$ | 60.1 |
| Salicyloyl | $o\text{-}HO{\cdot}C_6H_4{\cdot}CO{-}$ | 58.3 |
| Sebacoyl * | $-CO{\cdot}[CH_2]_8{\cdot}CO{-}$ | 58.3 |
| Selenino | $HO_2Se{-}$ | |
| Seleninyl | $OSe{=}$ | |
| Seleno | $-Se{-}$ | |
| Selenono | $HO_3Se{-}$ | |
| Selenonyl | $O_3Se{-}$ | |
| Selenyl | $HSe{-}$ | |
| Semicarbazido | $H_2N{\cdot}CO{\cdot}NH{\cdot}NH{-}$ | |
| Semicarbazono | $H_2N{\cdot}CO{\cdot}NH{\cdot}N{=}$ | |
| Seryl | $HO{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO{-}$ | 58.5 |
| Siloxy | $H_3Si{\cdot}O{-}$ | 70.6 |
| Silyl | $H_3Si{-}$ | 70.6 |
| Silylamino | $H_3Si{\cdot}NH{-}$ | 70.6 |
| Silyldisilanyl | $(H_3Si)_2SiH{-}$ | 70.6 |
| Silylene | $H_2Si{=}$ | 70.6 |
| Silylidyne | $HSi{\equiv}$ | 70.6 |
| Silylthio | $H_3Si{\cdot}S{-}$ | 70.6 |
| Stannyl | $H_3Sn{-}$ | |
| Stearoyl * | $CH_3{\cdot}[CH_2]_{16}{\cdot}CO{-}$ | 58.3 |
| Styryl | $C_6H_5{\cdot}CH{\vdots}CH{-}$ | 61.1 Ex |
| Suberoyl * | $-CO{\cdot}[CH_2]_6{\cdot}CO{-}$ | 58.3 |
| Succinamoyl | $NH_2{\cdot}CO{\cdot}CH_2{\cdot}CH_2{\cdot}CO{-}$ | 58.4 |
| Succinimido | $CO{\cdot}CH_2{\cdot}CH_2{\cdot}CO{\cdot}N{-}$ | 58.7 |
| Succinyl | $-CO{\cdot}CH_2{\cdot}CH_2{\cdot}CO{-}$ | 58.3 |
| Sulphamoyl | $NH_2{\cdot}SO_2{-}$ | 58.4 |
| Sulphanilyl | $p\text{-}H_2N{\cdot}C_6H_4{\cdot}SO_2{-}$ | 58.2 Ex |
| Sulphino | $HO_2S{-}$ | 52 |
| Sulphinyl | $-SO{-}$ | 58.2 |
| Sulpho | $HO{\cdot}SO_2{-}$ | 52 |
| Sulphoamino | $HO_3S{\cdot}NH{-}$ | 58.9 |
| Sulphonyl | $-SO_2{-}$ | 58.2 |
| Tartronoyl | $-CO{\cdot}CH(OH){\cdot}CO{-}$ | 58.3 |
| Tauryl | $H_2N{\cdot}CH_2{\cdot}CH_2{\cdot}SO_2{-}$ | 58.5 |
| Telluro | $-Te{-}$ | |
| Terephthaloyl | $-CO{\cdot}C_6H_4{\cdot}CO{-}$ (*p*-) | 58.3 |
| Tetracontyl | $CH_3{\cdot}[CH_2]_{38}{\cdot}CH_2{-}$ | 54.1 |
| Tetracosyl | $CH_3{\cdot}[CH_2]_{22}{\cdot}CH_2{-}$ | 54.1 |
| Tetradecanoyl ** | $CH_3{\cdot}[CH_2]_{12}{\cdot}CO{-}$ | 58.3 |
| Tetradecyl | $CH_3{\cdot}[CH_2]_{12}{\cdot}CH_2{-}$ | 54.1 |
| Tetrahydroglyoxalinyl | $N_2C_3H_7$ | 60.1 |
| Tetramethylene | $-CH_2{\cdot}[CH_2]_2{\cdot}CH_2{-}$ | 57.1 |
| Tetrazolyl | $N_4CH{-}$ | 60.1 |
| Thenoyl (2- *shown*) | $S{\cdot}CH{\vdots}CH{\cdot}CH{\vdots}C{\cdot}CO{-}$ | 58.3 |
| Thenyl | $SC_4H_3{\cdot}CH_2{-}$ | 61.1 Ex |
| Thenylidene | $SC_4H_3{\cdot}CH{=}$ | 56.2 |
| Thiazinyl | $NSC_4H_4{-}$ | 60.1 |
| Thiazolidinyl | $NSC_3H_6{-}$ | 60.1 |
| Thiazolinyl | $NSC_3H_4{-}$ | 60.1 |
| Thiazolyl | $NSC_3H_2{-}$ | 60.1 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Thienyl | $SC_4H_3-$ | 60.1 Ex |
| Thio | $-S-$ | |
| Thiocarbamoyl | $H_2N{\cdot}CS-$ | |
| Thiocarbonyl | $SC{=}$ | |
| Thiocyanato | $N{\vdots}C{\cdot}S-$ | |
| *iso*Thiocyanato | $S{:}C{:}N-$ | |
| Thioformyl | $SHC-$ | |
| Thionaphthenyl | $SC_8H_5-$ | 60.1 |
| Threonyl | $CH_3{\cdot}CH(OH){\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Thyronyl *p*-(*p*-$HO{\cdot}C_6H_4{\cdot}O$)-$C_6H_4{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | | 58.5 |
| Toluenesulphonyl ** | $CH_3{\cdot}C_6H_4{\cdot}SO_2-$ | 58.2 |
| Toluidino (*o*-, *m*-, and *p*-) | $CH_3{\cdot}C_6H_4{\cdot}NH-$ | 58.9 |
| Toluoyl (*o*-, *m*-, and *p*-) | $CH_3{\cdot}C_6H_4{\cdot}CO-$ | 58.3 |
| Tolyl (*o*-, *m*-, and *p*-) | $CH_3{\cdot}C_6H_4-$ | 59.1 Ex |
| Tosyl * (*p*- only) | *p*-$CH_3{\cdot}C_6H_4{\cdot}SO_2-$ | 58.2 Ex |
| Triacontyl | $CH_3{\cdot}[CH_2]_{28}{\cdot}CH_2-$ | 54.1 |
| Triazeno | $NH_2{\cdot}N{:}N-$ | |
| Triazinyl | $N_3C_3H_2-$ | 60.1 |
| Triazolidinyl | $N_3C_2H_6-$ | 60.1 |
| Triazolyl | $N_3C_2H_2-$ | 60.1 |
| Tricosyl | $CH_3{\cdot}[CH_2]_{21}{\cdot}CH_2-$ | 54.1 |
| Tridecanoyl | $CH_3{\cdot}[CH_2]_{11}{\cdot}CO-$ | 58.3 |
| Tridecyl | $CH_3{\cdot}[CH_2]_{11}{\cdot}CH_2-$ | 54.1 |
| 2 : 4 : 5-Trimethylanilino, *replacing* pseudo*cumidino* | 2 : 4 : 5 : 1-$(CH_3)_3C_6H_2{\cdot}NH-$ | 58.9 |
| 2 : 4 : 6-Trimethylanilino, *replacing mesidino* | 2 : 4 : 6 : 1-$(CH_3)_3C_6H_2{\cdot}NH-$ | 58.9 |
| Trimethylene | $-CH_2{\cdot}CH_2{\cdot}CH_2-$ | 57.1 |

| *Radical name* | *Formula* | *Based on rule no.* |
|---|---|---|
| Triphenylsilyl | $(C_6H_5)_3Si-$ | 70.6 |
| Trisilanyl | $H_3Si{\cdot}SiH_2{\cdot}SiH_2-$ | 70.6 |
| Trisilanylene | $-SiH_2{\cdot}SiH_2{\cdot}SiH_2-$ | 70.6 |
| Tritriacontyl | $CH_3{\cdot}[CH_2]_{31}{\cdot}CH_2-$ | 54.1 |
| Trityl | $(C_6H_5)_3C-$ | 61.1 Ex |
| Tropoyl | $C_6H_5{\cdot}CH(CH_2{\cdot}OH){\cdot}CO-$ | 58.3 |
| Tryptophyl | $NC_8H_6{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 Ex |
| Tyrosyl | *p*-$HO{\cdot}C_6H_4{\cdot}CH_2{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Undecanoyl | $CH_3{\cdot}[CH_2]_9{\cdot}CO-$ | 58.3 |
| Undecyl, *replacing hendecyl* | $CH_3{\cdot}[CH_2]_9{\cdot}CH_2-$ | 54.1 |
| Ureido | $NH_2{\cdot}CO{\cdot}NH-$ | 58.6 Ex |
| Ureylene | $-NH{\cdot}CO{\cdot}NH-$ | 36 |
| Valeryl | $CH_3{\cdot}[CH_2]_3{\cdot}CO-$ | 58.3 |
| *iso*Valeryl | $(CH_3)_2CH{\cdot}CH_2{\cdot}CO-$ | 58.3 |
| Valyl | $(CH_3)_2CH{\cdot}CH(NH_2){\cdot}CO-$ | 58.5 |
| Vanilloyl | 3 : 4 : 1-$CH_3O{\cdot}(HO)C_6H_3{\cdot}CO-$ | 58.3 |
| Veratroyl | 3 : 4 : 1-$(CH_3O)_2C_6H_3{\cdot}CO-$ | 58.3 |
| Vinyl, *preferred to ethenyl* | $CH_2{:}CH-$ | 55.1 Ex |
| Vinylene, *preferred to ethenylene* | $-CH{:}CH-$ | 57.2 |
| Vinylidene, *preferred to ethenylidene* | $CH_2{:}C{=}$ | 56.1 |
| Xanthenyl | $OC_{13}H_9-$ | 60.1 |
| Xylidino | $(CH_3)_2C_6H_3{\cdot}NH-$ | 58.9 |
| *xyloyl, see* Dimethylbenzoyl | | |
| Xylyl | $(CH_3)_2C_6H_3-$ | 59.1 Ex |

APPENDIX 2

## *Rules of Carbohydrate Nomenclature.*

[These rules have been agreed between the Carbohydrate Nomenclature Sub-Committee, appointed by the Publication Committee of the Chemical Society, and the Committee on Carbohydrate Nomenclature representing the Divisions of Sugar Chemistry and Technology, Chemical Education, and Biological Chemistry of the American Chemical Society. The Chemical Society's Sub-Committee had the benefit of co-operation with representatives of the Editorial Board of the Biochemical Society. The Publication Committee of the Chemical Society has approved the rules below and instructed that they shall be used forthwith in the Society's publications.

Discussions are still in progress on rules **24**, **31**, and **32**, which will deal with radicals derived from alditols and with acetals and their derivatives. Further aspects of carbohydrate nomenclature are also under consideration. Ed.]

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The following nomenclature rules are recommended for use whenever systematic names for carbohydrates and their derivatives are required.

**Rule 1** Carbohydrate nomenclature should follow the general principles of established organic nomenclature.

**Rule 2** As few changes as possible will be made in terminology universally adopted.

*Comment.* This is Rule 1 of the Definitive Report of the Commission on the Reform of Nomenclature of Organic Chemistry (**1930**) (*J. Amer. Chem. Soc.*, **1932**, **55**, 3905; cf. *J.*, **1952**, 5065). The rules of this Report will hereinafter be referred to as I.U.C. Rules (International Union of Chemistry Rules).

**Rule 3** The names " aldose " or " ketose " will be used in a generic sense to denote the respective character of the reducing, or potentially reducing, group of the monosaccharide or derivative thereof. In an aldose, the carbon atom of the aldehyde function is atom number one; and in a ketose, the carbonyl carbon atom has the lowest possible number.

For indicating the number of carbon atoms in the chain, the appropriate one of the following names will be used : triose, tetrose, pentose, hexose, heptose, octose, nonose, etc.

**Rule 4** Configurational relationships will be denoted by the capital letter prefixes D and L, which in print will be small capital Roman letters and which are pronounced " dee " and " ell " (not " dextro " and " lævo "). Such symbols will be placed immediately before the sugar stem name (see, however, Rules **23** and **28**, examples *c*), and be employed only with compounds which have been definitively related to the reference-standard glyceraldehyde (see Rule 5). In a definitive name, the configurational symbol should not be omitted.

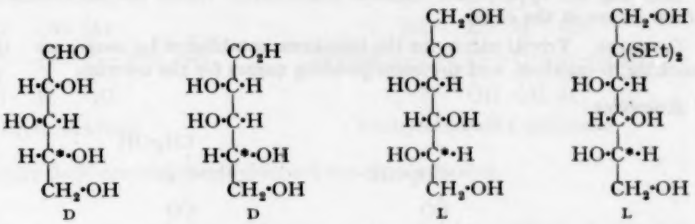
If optical rotational sign under specified conditions is to be indicated, this may be done by adding (*dextro*) or (*lævo*), which are italicized in print, or by adding (+) or (−). Racemic modifications may be indicated by the prefixes DL, or (±), or *inactive*, the last being italicized in print.

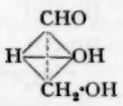
*Examples* : D-glucose or D(*dextro*)-glucose or D(+)-glucose
D-fructose or D(*lævo*)-fructose or D(−)-fructose
DL-glucose, or (±)-glucose, or *inactive*-glucose

**Rule 5** Carbohydrates having the same configuration of the highest-numbered asymmetric carbon atom as that of D(*dextro*)-glyceraldehyde will belong to the D-configurational series; those having the opposite configuration will belong to the L-series.

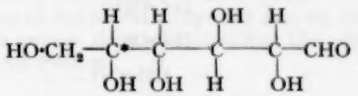
D(*dextro*)-Glyceraldehyde, the configurational reference standard, is by assumption written as (*A*).

*Examples*:




(*A*)




D-glucose

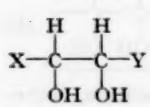
**Rule 6** The configuration of a group of consecutive but not necessarily contiguous asymmetric carbon atoms (such as >CH·OH, >CH·OMe, >CH·OAc, or >CH·$NH_2$), containing one to four asymmetric carbon atoms, will be designated by the appropriate one of these prefixes:

| Asymmetric carbon atoms | Prefixes |
|---|---|
| One | *glycero* |
| Two | *threo*, *erythro* |
| Three | *arabo* (*arabino*), *ribo*, *xylo*, *lyxo* |
| Four | *gluco*, *manno*, *gulo*, *ido*, *talo*, *galacto* (*gala*), *allo*, *altro* |

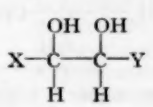
Each is D or L, as D-*talo* or L-*manno*. The prefix, which is derived by omitting the last two letters from the name of the aldose having the same configuration as the group to which it refers, is not to be capitalized and will be italicized in print.

*Comment*. As regards derivation, exceptions established by usage are *arabo* and *gala*.

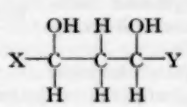
*Examples*: In each formula below, the principal function is at Y.

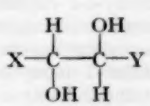



D-*erythro*

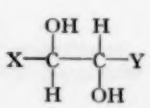



L-*erythro*

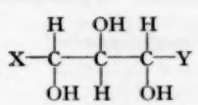


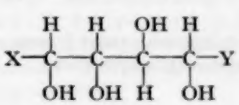

D-*threo*



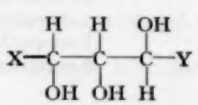

L-*threo*



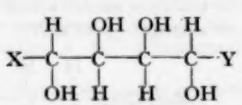

D-*xylo*



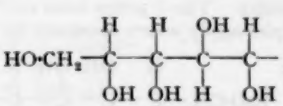

D-*gluco*




D-*arabo*
D-*arabino*




D-*galacto*
D-*gala*



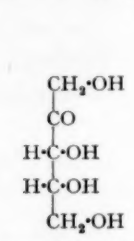

D-*gluco*pentahydroxypentyl

**Rule 7** Ketoses having the carbonyl group at carbon atom number two will be named by means of the suffix " -ulose "; before this will be a prefix denoting the number of carbon atoms in the chain, which, in turn, will be preceded by the prefix denoting the configuration of the group of asymmetric centres present (see Rule 6).

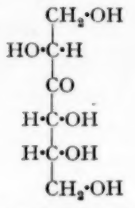
Ketoses having the carbonyl group at a carbon atom other than number two will be named by inserting the appropriate numeral immediately before the prefix denoting the number of carbon atoms in the chain.

*Comment.* Trivial names for the hexuloses, established by usage, are : D-fructose, D-psicose, D-sorbose, D-tagatose, and the corresponding names for the L-forms.

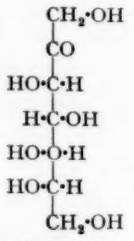
*Examples* :



D-*erythro*pentulose



D-*arabo*-3-hexulose

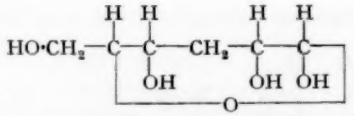


L-*gluco*heptulose

**Rule 8** When an alcoholic hydroxyl group of a monosaccharide is replaced by a hydrogen atom, the compound will be named by attaching by a hyphen, before the sugar name, the appropriate numeral (indicating position), a hyphen, and the prefix " deoxy." The configuration of the sugar will be designated, when necessary, as given in Rule 6. This deoxy-moiety can be further substituted.

*Comment.* Trivial names, established by usage, include : L-rhamnose (6-deoxy-L-mannose); D-fucose (6-deoxy-D-galactose); and D-*epi*rhamnose (6-deoxy-D-glucose).

*Examples* : 2-deoxy*aldehydo*-L-*xylo*hexose
4-deoxy-α-D-*glycero*pentulofuranose (see Rule 18)
2 : 6-dideoxy-3-*O*-methyl-β-D-*lyxo*hexopyranose (see Rule 18)
6-deoxy-α-L-idofuranose
2-deoxy-D-*erythro*pentose (2-deoxy-D-arabinose or, as commonly termed, 2-deoxy-D-ribose)
6-deoxy-6-iodo-α-D-galactopyranose
2-chloro-2-deoxy-α-D-glucopyranose
3-deoxy-α-D-*ribo*hexopyranose (3-deoxy-α-D-glucopyranose or 3-deoxy-α-D-allopyranose) (*B*)

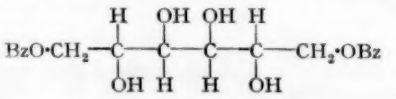


(*B*)

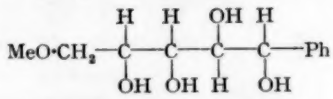
3-amino-3-deoxy-β-L-galactofuranose
2-amino-2-deoxy-α-D-glucopyranose (common names : D-glucosamine, chitosamine)
2-amino-2-deoxy-α-D-galactopyranose (common names : D-galactosamine, chondrosamine)
1-amino-1-deoxy-α-D-fructofuranose (common name : *iso*glucosamine)
2-acetamido-2-deoxy-α-D-glucopyranose

**Rule 9** When the hydrogen atom of an alcoholic hydroxyl group of a carbohydrate is substituted, an italic capital letter *O* (for oxygen) will be attached by a hyphen directly before the substituting prefix. The *O* prefix need not be repeated for multiple substitutions by one group. Similar principles apply where necessary to substitution on nitrogen (prefix, *N*).

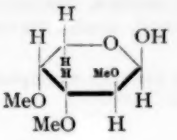
*Examples* :



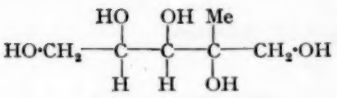
1 : 6 di-*O*-benzoyldulcitol



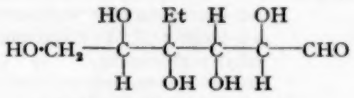
5-O-methyl-1-phenyl-D-*gluco*pentitol



2 : 3 : 4-tri-*O*-methyl-β-D-arabinose



2-methyl-L-arabitol



4-ethyl*aldehydo*-L-galactose

2-deoxy-2-(*N*-acetyl-*N*-methylamino)-α-L-glucopyranose

**Rule 10** When the hydrogen atom of an alcoholic hydroxyl group of a carbohydrate (see Rule 9) is substituted by another atom or group, the name of the parent compound may be retained as the root for the substituted compound. In such names, the prefix (denoting the substituent) will be attached directly to the root and not spaced from it.

*Comment.* See Rule 16.

*Examples* : 2 : 3 : 4 : 6-tetra-*O*-methyl-α-D-glucose
hexa-*O*-acetyldulcitol
2-*O*-methyl-β-D-glucose
penta-*O*-propionyl-β-D-galactopyranose

**Rule 11** A radical formed from a sugar by removal of an alcoholic hydroxyl group will be indicated by placing, after the sugar name and separated therefore by a space, the appropriate numeral (indicating position) and a hyphen as prefix to the name of the group attached to the sugar radical.

*Examples* : α-D-glucopyranose 3-acetate
methyl β-D-talofuranoside 2-benzoate

*Comment.* Naming of *O*-acyl derivatives of carbohydrates may follow this terminology or Rule 9.

*Examples* : (a) *Esters of monobasic carboxylic acids* :

1, glycerol triacetate; tri-*O*-acetylglycerol
2, glycerol 1 : 3-dipropionate; 1 : 3-di-*O*-propionylglycerol
3, α-D-glucopyranose penta-acetate; penta-*O*-acetyl-α-D-glucopyranose
4, β-L-mannofuranuronic acid 2-benzoate; 2-*O*-benzoyl-β-L-mannofuranuronic acid

(b) *Esters of sulphonic acids* :

1, methyl β-D-galactoside 2 : 3 : 4-triacetate 6-methanesulphonate or methyl 2 : 3 : 4-tri-*O*-acetyl-6-*O*-methanesulphonyl-β-D-galactoside
2, methyl α-D-glucopyranoside 6-toluene-*p*-sulphonate or methyl 6-*O*-toluene-*p*-sulphonyl-α-D-glucopyranoside

(c) *Esters of nitric acid* are usually named by Rule 11 :

1, methyl β-D-galactopyranoside 6-nitrate
2, D-mannitol 1 : 6-dinitrate
3, methyl 4 : 6-*O*-ethylidene-β-D-glucoside 2 : 3-dinitrate

(d) *Esters of polybasic acids* are usually named by Rule 11 :

1, β-D-glucopyranose 6-(dihydrogen phosphate)
2, α-D-glucofuranose 6-(disodium phosphate)
Cf. also footnote to rule 25 (p. 5116).

**Rule 12** Class terms (excepting amine) such as acetal, acetate, alcohol, ether, glycoside, ketone, sulphide, xyloside, and the like, which, when used singly, represent no definite unsubstituted compound, are used as separate words.

*Comment.* This is in conformity with established usage for such examples as methyl ether and ethyl methyl ketone.

*Examples*: β-L-mannopyranose 3-acetate
β-D-glucopyranose penta-acetate
β-D-idose 2 : 3 : 4 : 6-tetramethyl ether
ethyl D-gluconate
methyl α-D-mannopyranoside
ethyl β-L-xylopyranoside

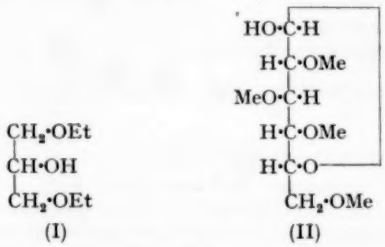
**Rule 13** When ethers of polyols (glycols, glycerol, polyhydric phenols, carbohydrates, and the like) are named as ethers, the name of the polyol (a one-word name) will be the first word, " ether " the last word, and the name of the appropriate radical (or radicals) will be the middle word (or words).

*Comment.* The term " ether " does not apply to compounds derived by substitution of the hydrogen of the hemiacetal hydroxyl group attached to the reducing or glycosidic carbon atom.

Names of bivalent and tervalent radicals derived by removal of two or of three hydrogen atoms from the *same* carbon atom are sanctioned in the I.U.C. nomenclature (namely, propylidene, I.U.C. Rule 56).

Except for a few established names, however, I.U.C. Rules 21, 33, and 62 show avoidance of distinctive names for multivalent radicals derived by removal of hydrogen atoms from *different* carbon atoms. The illustrations given below (with glycerol and D-glucose as first names) are in conformity with this decision. Names such as " glyceryl α-monomethyl ether " and " glyceryl αγ-dimethyl ether " have been used; here " glyceryl " is used incorrectly to denote two different radicals. In " glyceryl trimethyl ether," a third " glyceryl " radical would appear. It is obvious that a ruling should be made against the incorrect use of such multivalent radicals in the naming of polyhydroxy-derivatives.

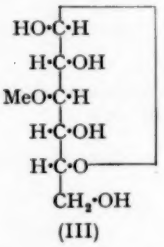
*Examples*:



(I)



(II)



(III)

(I) glycerol 1 : 3-diethyl ether (synonyms : 1 : 3-diethoxypropan-2-ol and 1 : 3-di-*O*-ethylglycerol)
(II) β-D-glucose 2 : 3 : 4 : 6-tetramethyl ether, or β-D-glucopyranose tetramethyl ether (synonym : 2 : 3 : 4 : 6-tetra-*O*-methyl-β-D-glucose)
(III) β-D-glucopyranose 3-methyl ether (synonym : 3-*O*-methyl-β-D-glucopyranose)

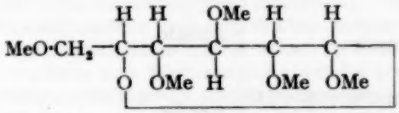
**Rule 14** When a prefix is attached to one of the words in a two- or a three-word name, it modifies only the word to which it is attached and does not modify the remaining words in the name. But if a preceding word in this name is the name of a compound, numerals to indicate position of substitution in it may be placed before the following word (see Rule 11). If necessary, parentheses should be used to avoid ambiguity. Unless otherwise specified (Rules 15 and 17), prefixes take an alphabetical order, regardless of the numerical prefix of each; a compound radical name is treated as a unit.

Thus, triacetyl and diacetyl are to be listed under acetyl. Anhydro-, deoxy-, and dihydro- are prefixes.*

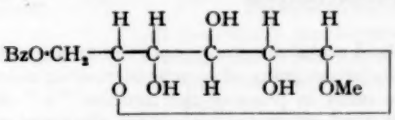
* In carbohydrate chemistry, all prefixes not in special type are alphabeticized. The three named are alphabeticized under a, d, and h, respectively.

*Comment.* This is in conformity with established usage; for example, MeO·$CH_2$·$CO_2$Me: methyl methoxyacetate.

*Examples*:



methyl 2 : 3 : 4 : 6-tetra-*O*-methyl-α-D-glucoside



methyl 6-*O*-benzoyl-α-D-glucopyranoside

ethyl 2 : 3 : 4-tri-*O*-acetyl-6-*O*-benzenesulphonyl-α-D-glucoside
methyl 3-*O*-2′-chloroethyl-β-D-glucopyranoside

**Rule 15** The anomeric prefix (α- or β-), which can only be used in conjunction with a configurational prefix (D or L), will immediately precede the latter. The configurational prefix will directly precede the stem name (see Rule 6).

*Comment.* In some accepted trivial names (see last example below) the configurational prefix is understood and may be omitted.

*Examples*: α-D-*gluco*heptulopyranose
ethyl β-D-galactofuranoside
methyl α-D-glucopyranoside
methyl β-cellobioside

**Rule 16** In conformity with established practice, hyphens will be used in names to connect numerals to syllables, or to separate different kinds of characters such as Roman letters from Greek letters or letters from numerals.

[This and similar types of usage follow established practice in the *Journal*. Ed.]

*Examples*: α-D-glucose
3-*O*-methyl-β-L-mannose
penta-*O*-acetyl-α-D-glucopyranose
methyl 2 : 3 : 6-tri-*O*-acetyl-α-D-glucopyranoside
aldo-octose
1 : 3-4 : 6-di-*O*-methylenedulcitol (see Rule 30)
2-*O*-methyl-3 : 4-dimethyl-D-glucose

**Rule 17** The acyclic nature of a sugar or derivative containing an unmodified CHO or CO group as the primary function will be indicated by inserting the italicized prefix *aldehydo* or *keto*, respectively, immediately before the configurational prefix and stem name.

*Examples*: *aldehydo*-D-glucose penta-acetate
3 : 6-anhydro*aldehydo*-D-galactose
*keto*-D-fructose pentabenzoate

**Rule 18** The size of the ring in the heterocyclic forms of monosaccharides (both aldoses and ketoses) may be indicated by replacing, in the sugar name, the letters " se " by " furanose " for the 5-atom ring; " pyranose " for the 6-atom ring; and " septanose " for the 7-atom ring. Likewise, for the glycosides (both aldosides and ketosides), the size of the ring may be revealed by replacing the syllable " side " by " furanoside," " pyranoside," or " septanoside."

*Examples*: α-L-idofuranose
methyl β-D-*altro*heptulopyranoside

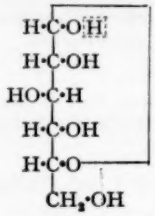
**Rule 19** The root " glyc " (as in glycose or glycoside) will be used in a generic sense to denote any sugar or derivative thereof, rather than some specified sugar.

*Examples* : glycose, methyl glycoside } generic

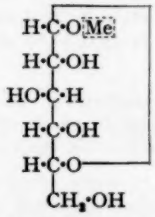
β-L-glucose
methyl α-D-glucopyranoside
ethyl β-D-altropyranoside
methyl β-L-fructofuranoside } specific

**Rule 20** A glycoside is a mixed acetal resulting from the exchange of an organic radical for the hydrogen of the hemiacetal hydroxyl group of a cyclic form of an aldose or ketose. It is named by substituting " ide " as a suffix in place of the terminal " e " of the corresponding sugar name and placing before this word, separated by a space, the name of the organic substituent.

*Examples* :



α-D-glucopyranose



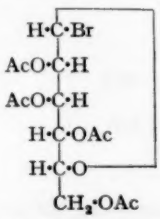
methyl α-D-glucopyranoside

methyl 2-amino-2-deoxy-α-D-glucopyranoside (common name : methyl α-D-glucosaminide)

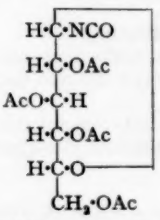
**Rule 21** If the hemiacetal hydroxyl group is detached from a cyclic modification of an aldose or ketose, the residue is a glycosyl (glycofuranosyl, glycopyranosyl, glycoseptanosyl) radical. It is named by substituting " yl " as a suffix in place of the terminal " e " of the corresponding sugar name.

*Comment.* A glycosyloxy-radical is identical with a glycoside radical (see Rule 20).

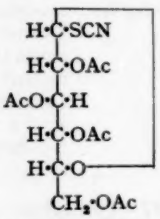
*Examples* :



tetra-*O*-acetyl-α-D-mannopyranosyl bromide



tetra-*O*-acetyl-α-D-glucopyranosyl *iso*cyanate



tetra-*O*-acetyl-α-D-glucopyranosyl thiocyanate

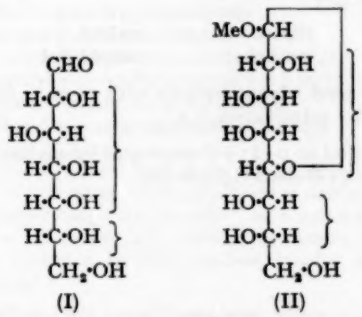
*N*-methyl-6-*O*-methyl-β-L-talofuranosylamine
*N*-*n*-butyl-α-D-glucopyranosylamine
*N*-phenyl-α-D-glucopyranosylamine (common name : D-glucose anilide)
*N*-hydroxy-α-D-glucopyranosylamine (common name : D-glucose oxime)
9-*N*-β-D-ribofuranosyladenine (common name : adenosine)
9-*N*-(2 : 3 : 5-tri-*O*-acetyl-β-D-ribosyl)adenine

**Rule 22** A monosaccharide containing more than four configurational asymmetric carbon atoms will be named by adding two or more prefixes indicating the configurations of those asymmetric carbon atoms to a root indicating the number of carbon atoms in the chain and ending with the suffix " -ose " for aldoses and " -ulose " for ketoses.

The configurational prefixes employed are given in Rule 6. The sequence of asymmetric carbon atoms will be divided into units, commencing, with a four-carbon unit, at the asymmetric carbon atom (or atoms) next to the functional group (see below). The order of citation of these prefixes will commence at the end farthest from carbon atom number one, and proceed along the carbon chain to the asymmetric carbon atom nearest to carbon atom number one. In designating anomeric ring forms of aldoses and 2-ketoses the anomeric prefix here (see Rule 15) will immediately precede the configurational prefix nearest to the root name.

| No. of asymmetric carbon atoms in the sequence | Prefixes to be used |
|---|---|
| 5 | one 4-carbon + one 1-carbon |
| 6 | one 4-carbon + one 2-carbon |
| 7 | one 4-carbon + one 3-carbon |
| 8 | two 4-carbon |
| 9 | two 4-carbon + one 1-carbon |
| 10 | two 4-carbon + one 2-carbon |
| 11, etc. | two 4-carbon + one 3-carbon, etc. |

*Examples*:



(I)



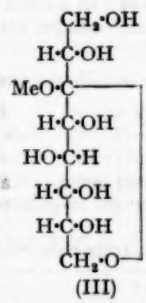
(II)

(I) D-*glycero*-D-*gluco*heptose.

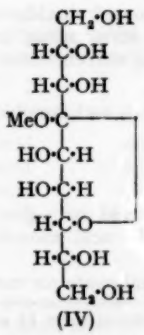
(II) methyl L-*erythro*-β-D-*galacto*octopyranoside.

For oxygen-ring forms of ketoses other than 2-ketoses, the ending (furanose, furanoside, etc.) will, when necessary, be immediately preceded by a pair of numerals identifying the two carbon atoms to which the oxygen ring is attached, the potential ketone group being cited first. When the potential ketone group of an oxygen-ring form is in the middle of the chain, the numerals identifying the position of the original hydroxyl group will be the higher of the two possibilities (see example VI).

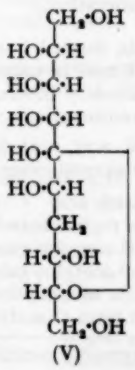
*Examples*:



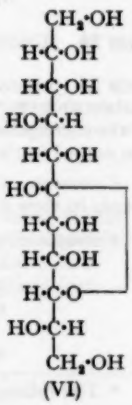
(III)



(IV)



(V)



(VI)

(III) methyl D-*gluco*-D-*glycero*-3-octuloseptanoside
(IV) methyl D-*manno*-D-*erythro*-4-nonulo-4→7-furanoside
(V) 7-deoxy-D-*arabo*-L-*ribo*-5-deculo-5→9-pyranose
(VI) L-*talo*-D-*gulo*-6-undeculo-6→9-furanose

*Comment.* Methods for naming, as well as representing correctly, the configuration of the anomeric forms of these ketoses can be devised when such compounds are prepared and their configurations determined.

**Rule 23** Names for the polyhydric alcohols (alditols) are derived from the names of the corresponding aldose sugars by changing the suffix " ose " to " itol." For non-*meso*-compounds, the same family-determining asymmetric carbon as that characterizing the name of the sugar is used.

*Examples of* (*a*) Permissible names established by usage :

| | | | |
|---|---|---|---|
| glycerol | for glyceritol | dulcitol | for galactitol |
| adonitol | for ribitol | perseitol | |
| arabitol | for arabinitol | volemitol | |
| sorbitol | for D-glucitol | | |

(*b*) Names requiring D or L :

threitol arabitol mannitol glucitol iditol talitol rhamnitol

(*c*) Names used without D or L :

| | | | | |
|---|---|---|---|---|
| glycerol | erythritol | ribitol | xylitol | sorbitol |
| allitol | dulcitol | lactitol | cellobi-itol | melibi-itol |

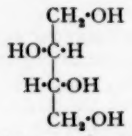
The names of *meso*-forms can be used advantageously with D- or L- in naming derivatives which have become optically active by substitution, *e.g.* :

**2 : 3-*O*-*iso*propylidene-D-xylitol** or **D-(2 : 3-*O*-*iso*propylidenexylitol)**
**1-*O*-methyl-L-glyceritol** or **L-(1-*O*-methylglyceritol)**

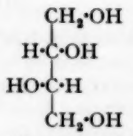
(*d*) Equivalent names :

D-arabitol and D-lyxitol
D-talitol and D-altritol
D-glucitol and L-gulitol

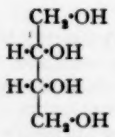
(*e*)



D(*dextro*)-threitol
D(+)-threitol



L(*lævo*)-threitol
L(−)-threitol



erythritol

**Rule 24** (Under consideration.)

**Rule 25** Aldonic acids, formed from aldoses by oxidation of only the hemiacetal or aldehydic carbon atom to $-CO_2H$, may be named by substituting " onic acid " as a suffix in place of " ose " of the corresponding aldose. Esters, salts, acid chlorides, lactones, amides, nitriles, and the like, are named in the conventional manner.

*Comment.* Glyceric acid, arabonic acid, and lactobionic acid will be considered acceptable names in view of their general usage.

*Examples* : cellobionic acid
barium D-gluconate •
penta-*O*-acetyl-D-gluconic acid (or D-gluconic acid penta-acetate)
penta-*O*-acetyl-D-galactonic acid monohydrate (or D-galactonic acid penta-acetate monohydrate)
methyl tetra-*O*-acetyl-L-arabonate (or methyl L-arabonate tetra-acetate)

---

• The following exemplify combinations of rules 11 and 25 :

barium D-gluconate 6-(dihydrogen phosphate)
barium D-gluconate 6-(sodium hydrogen phosphate)
barium D-gluconate 6-(disodium phosphate)
barium D-gluconate 6-(barium phosphate)

*Examples (contd.)*: D-glucono-γ-lactone; D-glucono-1→4-lactone; D-gluconic 1→4-lactone; D-gluconic γ-lactone *
D-glucono-δ-lactone; D-glucono-1→5-lactone; D-gluconic 1 : 5→lactone; D-gluconic δ-lactone
2 : 3 : 4 : 6-tetra-*O*-methyl-L-altronolactone (or 2 : 3 : 4 : 6-tetra-*O*-methyl-L-altronic lactone)
2-amino-2-deoxy-D-gluconic acid (common name: D-glucosaminic acid)

**Rule 26** Uronic acids, formed from aldoses having a terminal $-CH_2 \cdot OH$ group by oxidation only of this group to $-CO_2H$, may be named by substituting " uronic acid " as a suffix in place of " ose " of the corresponding aldose name. The hemiacetal or aldehydic carbon atom is carbon number one, and the syllable " ur " has the significance of " ω."

Esters, salts, acid chlorides, lactones, amides, nitriles, and the like, are named in the conventional manner.

*Examples*: α-D-mannopyranuronic acid
tetra-*O*-acetyl-β-D-talopyranuronic acid (or β-D-talopyranuronic acid tetraacetate)
methyl β-L-galactopyranuronate
barium α-L-glucofuranuronate
ethyl tetra-*O*-benzoyl-α-D-idofuranuronate
3-*O*-methyl-α-D-ribofuranurono-5→2-lactone
α-D-mannopyranurono-6→2-lactone
2-*O*-ethyl-β-L-glucopyranurono-γ-lactone

**Rule 27** If the glycoside radical (see Rule 20) of an aldose glycoside possesses a terminal $-CH_2 \cdot OH$ group, and if this group of the glycoside is oxidized to a carboxyl group, the product may be named by substituting " uronic acid " as a suffix in place of the terminal " e " of the parent glycoside name. The glycoside hemiacetal carbon atom is carbon number one.

Esters, salts, acid chlorides, lactones, amides, nitriles, and the like, may then be named in the conventional manner.

*Comment.* Parentheses are suitably inserted where it is necessary to distinguish between an ester alkyl group and the hemiacetal alkyl group of a glycoside of a uronic acid.

*Examples*: methyl α-D-mannopyranosiduronic acid
ethyl tri-*O*-benzoyl-α-D-idofuranosiduronic acid
methyl α-D-glucopyranosidurono-γ-lactone (or -6→3-lactone) †
ethyl 3-*O*-ethyl-β-L-glucopyranosidurono-δ-lactone (or -6→2-lactone) †
ethyl (methyl β-L-galactopyranosid)uronate
barium (bornyl α-D-glucofuranosid)uronate
*n*-butyl (*n*-propyl tri-*O*-acetyl-β-D-talopyranosid)uronate
methyl (ethyl 2 : 3 : 4-tri-*O*-methyl-α-D-galactosid)uronate

**Rule 28** αω-Dicarboxylic sugar acids (glycaric acids), formed by the oxidation of aldoses at both terminal carbon atoms, may be named by substituting " aric acid " as a suffix in place of " ose " of the corresponding aldose name.

*Examples of*: (*a*) Permissible names established by usage:

| | | | |
|---|---|---|---|
| tartronic acid | for glyceraric acid | mannosaccharic acid | for mannaric acid |
| (+)-tartaric acid | for L-threaric acid | mucic acid | for galactaric acid |
| *meso*tartaric acid | for erythraric acid | allomucic acid | for allaric acid |
| saccharic acid | for D-glucaric acid | talomucic acid | for talaric acid |
| idosaccharic acid | for idaric acid | | |

(*b*) Names requiring D or L:

| | | |
|---|---|---|
| threaric acid | glucaric acid | idaric acid |
| arabinaric (arabaric) acid | talaric acid | mannaric acid |

* A dilactone is exemplified by saccharic 1→4 : 6→3-dilactone. Note that the first of a pair of positional numerals cited refers to the acid group.

† See rule 25 for alternative methods of naming the lactone grouping.

(*c*) Names used without D or L :

| | | |
|---|---|---|
| glyceraric acid | ribaric acid | allaric acid |
| erythraric acid | xylaric acid | galactaric acid |

The names of *meso*-forms can be used advantageously with D or L in naming derivatives which have become optically active by substitution (cf. Rule 23*c*).

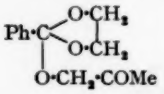
(*d*) Equivalent names :

lyxaric acid and arabinaric acid
talaric acid and altraric acid
L-gularic acid and D-glucaric acid

**Rule 29** The " glycosides of ortho-ester structure " may be named as the ortho-esters, with the carbohydrate group given as the first term in the name.

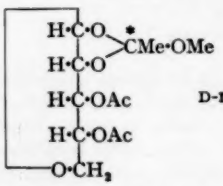
*Comment.* This is in conformity with established usage for such compounds as :

$Me{\cdot}C(OEt)_3$ ethyl orthoacetate



acetonyl ethylene orthobenzoate

*Examples* : (*a*)

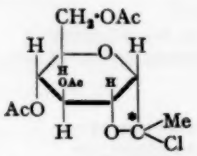


D-ribose 3 : 4-diacetate 1 : 2-(methyl orthoacetate)

It is to be noted that this compound may also be named according to Rule 30 as 3 : 4-di-*O*-acetyl-1 : 2-*O*-1′-methoxyethylidene-D-ribose.

The latter system appears to be the better for assignment of an accurate name to the following compound :

(*b*)

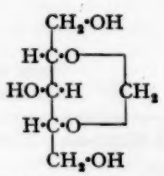


3 : 4 : 6-tri-*O*-acetyl-1 : 2-*O*-1′-chloroethylidene-α-D-glucose

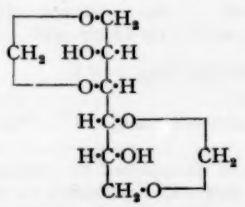
*Comment.* These two examples contain an asymmetric carbon atom marked *, and so two forms are possible. No recommendations are made at present for their differentiation.

**Rule 30.** Cyclic acetals formed by the reaction of carbohydrates with aldehydes or ketones may be named in accordance with Rule 9 with bivalent radicals as prefixes, such radicals to follow the nomenclature set forth in I.U.P.A.C. Rule 56. In representing more than one cyclic acetal grouping, the numeral pairs are separated typographically when the exact placement of the acetal groups is known.

*Examples* :



2 : 4-*O*-methylenexylitol



1 : 3-4 : 6-di-*O*-methylene-D-mannitol

(I) 1 : 2-*O*-*iso*propylidene-D-glucofuranose
(II) 1 : 2-4 : 5-di-*O*-*iso*propylidene-D-fructopyranose
(III) 4 : 6-*O*-ethylidene-D-glucose
(IV) 1 : 2-3 : 4-bis-*O*-1′-methylpropylidene-D-xylose
(V) methyl 4 : 6-*O*-benzylidene-α-D-glucoside
(VI) 1 : 2-*O*-2′-chloroethylidene-α-D-glucofuranose
(VII) 1 : 2-*O*-1′-chloroethylidene-α-D-glucopyranose triacetate

*Comment.* It is to be noted that in examples (III—VII inclusive), new asymmetric centres are introduced at the carbonyl-carbon atom of the aldehyde or ketone that has reacted with the sugar. In (IV), two such new centres have been introduced. A differentiating nomenclature for such isomers is not here attempted.

**Rules 31, 32** (Under consideration.)

**Rule 33** An intramolecular anhydride, formed by the elimination of the elements of water from two hydroxyl groups of a monosaccharide molecule (aldose or ketose), is named by attaching the prefix " anhydro " to the sugar name; this prefix is preceded by a pair of numerals identifying the two hydroxyl groups involved. Anhydrides of sugar acids, lactones, alcohols, and the like, are named similarly.

*Comment.* The substances usually known as sugar anhydrides, glycose anhydrides, or glycosans (whose formation involves the reducing group), as well as the anhydro-sugars (whose formation does not involve the reducing group) are not here differentiated in treatment. The name " levoglucosan " (for 1 : 6-anhydro-β-D-glucopyranose) is established by usage, but, except for this, names of glucosan type should not be used.

*Examples* : 3 : 6-anhydro*aldehydo*-D-glucose
3 : 6-anhydro-β-D-glucofuranose
2 : 3-anhydro-4-*O*-methyl-α-D-mannopyranose
2 : 7-anhydro-β-D-*altro*heptulopyranose
1 : 6-3 : 4-dianhydro-β-D-talopyranose
methyl 4 : 6-di-*O*-acetyl-2 : 3-anhydro-α-D-alloside
2 : 5-anhydro-D-gluconic acid
3 : 6-anhydro-D-gluconic 1→4-lactone
1 : 4-3 : 6-dianhydro-D-glucitol, or 1 : 4-3 : 6-dianhydro-L-gulitol (see Rule 23)

**Rule 34** An intermolecular anhydride, formed by condensation of two monosaccharide molecules with the elimination of the elements of two molecules of water, will be named by the word " dianhydride " placed after the names of the two parent sugars. The position of each anhydride link is indicated by a pair of numerals showing the positions of the two hydroxyl groups involved; the numerals relating to one sugar (in a mixed dianhydride, the second sugar named) will be primed. In each numeral pair, the first number cited will be that which carries an anomeric prefix; both pairs of numerals will immediately precede the word " dianhydride."

*Examples* : di-D-fructopyranose 2 : 1′-2′ : 1-dianhydride
di-D-fructofuranose 2β : 3′-2′β : 1-dianhydride
D-fructofuranose D-*threo*pentulofuranose 2β : 1′-2′β : 1-dianhydride

**Rule 35** An oligosaccharide is a compound which, on complete hydrolysis, gives monosaccharides only, in relatively small number per molecule (in contrast to the high-polymeric polysaccharides).

*Comment.* Most of the naturally occurring oligosaccharides have well-established and useful common names (sucrose, lactose, maltose, cellobiose, melezitose, raffinose, stachyose) which were assigned before their complete structures were known. Rational names may now be assigned as follows.

*Disaccharides.* A reducing disaccharide may be named as a glycosylaldose (glycosylketose), and a non-reducing disaccharide as a glycosyl aldoside (glycosyl ketoside), from its component parts.

*Examples* : (*a*) Reducing :

α-lactose : 4-*O*-β-D-galactopyranosyl-α-D-glucopyranose

(*b*) Non-reducing :

sucrose : β-D-fructofuranosyl α-D-glucopyranoside, or α-D-glucopyranosyl β-D-fructofuranoside

(*c*) Glycosides of reducing disaccharides :

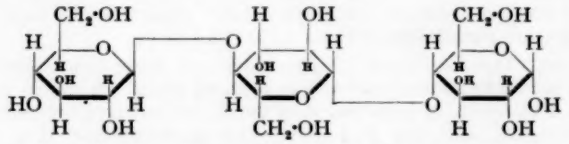
methyl α-lactoside : methyl 4-*O*-β-D-galactopyranosyl-α-D-glucopyranoside

*Tri- and Higher Oligo-saccharides*.

(a) *Reducing* : Beginning with the first non-reducing component, and following Rule 20, the first glycosyl portion with its configurational prefixes is delineated. This is followed by two numbers, separated by an arrow, in parentheses inserted into the name by hyphens. This numeral pair indicates the respective positions involved in the first glycosidic union, the first number giving the position on the terminal non-reducing component and the second referring to the position on the other component concerned. The next disaccharide linkage is treated similarly (and so on), and the last portion of the name delineates the reducing sugar unit.

*Examples* :

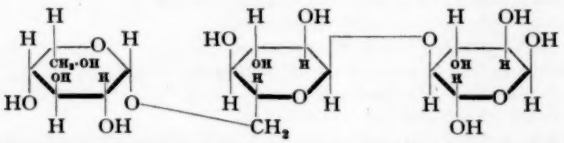
α-cellotriose :



*O*-β-D-glucopyranosyl-(1→4)-*O*-β-D-glucopyranosyl-(1→4)-α-D-glucopyranose

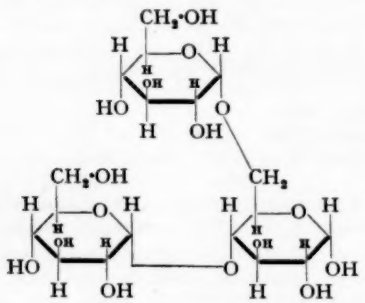
α-maltotriose :

*O*-α-D-glucopyranosyl-(1→4)-*O*-α-D-glucopyranosyl-(1→4)-α-D-glucopyranose



*O*-α-D-glucopyranosyl-(1→6)-*O*-α-D-glucopyranosyl-(1→4)-α-D-glucopyranose

*Reducing, branched* : By insertion in brackets, one glycosyl substituent is distinguished from the second glycosyl substituent.



*O*-α-D-glucopyranosyl-(1→4)-*O*-[α-D-glucopyranosyl-(1→6)]-α-D-glucopyranose {synonym : 4 : 6-di-*O*-α-D-glucopyranosyl-α-D-glucopyranose}

(b) *Non-reducing* :

raffinose : *O*-α-D-galactopyranosyl-(1→6)-*O*-α-D-glucopyranosyl-(1→2) β-D-fructofuranoside or *O*-β-D-fructofuranosyl-(2→1)-*O*-α-D-glucopyranosyl-(6→1) α-D-galactopyranoside

gentianose : *O*-β-D-glucopyranosyl-(1→6)-*O*-α-D-glucopyranosyl-(1→2) β-D-fructofuranoside

*Conventions regarding Symbols for representing Complex Carbohydrates.*

In abbreviated, structural representation of complex carbohydrates, the following symbols may be convenient.

1. *Radicals derived from monosaccharides.* For trioses to hexoses, the first three letters of the name are used; an exception is that "glucose" is denoted by G. The first of the three letters is capitalized.

*Examples*: galactose, Gal; fructose, Fru; ribose, Rib; 2-deoxyribose, 2-deoxyRib

2. *Furanose, pyranose, and septanose forms.* If necessary, the first letter of the syllable, italicized and uncapitalized, is used as suffix to denote the ring form.

*Examples*: idofuranose, Ido*f*; mannopyranose, Man*p*

3. *Uronic acids.* The suffix "A" (for "acid") is added to the symbol for the parent monosaccharide.

*Examples*: galactofuranuronic acid, Gal*f*A; mannopyranuronic acid, Man*p*A

4. *2-Amino-2-deoxy-aldoses.* The suffix "N" (for "nitrogen") is added to the symbol for the parent monosaccharide. The *N*-acetyl derivative is denoted by the suffix NAc.

*Examples*: glucosamine, GN; *N*-acetylgalactosamine, GalNAc

5. *Configurational series.* The configurational symbols (Rule 4) are not to be omitted when established.

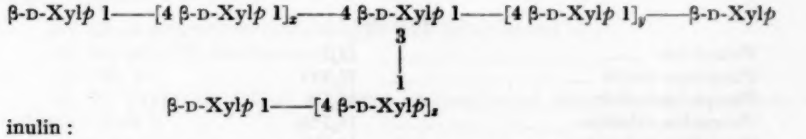
*Example*: L-arabinose, L-Ara

6. *Positional numerals and anomeric prefixes.* These are added at the appropriate places, the former being separated from the monosaccharide symbol by a thin space.

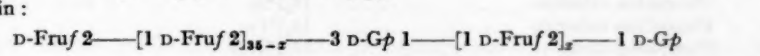
7. *Joining of symbols.* Symbols formed as above are joined by rules.

8. *Arrays.* Polydirectional arrays may be used.

*Examples*: xylan:




inulin:



APPENDIX 3

## *Nomenclature of Compounds containing One Phosphorus Atom.*

Note 1. This system of nomenclature is readily expansible to arsenic, antimony, and, if desirable, bismuth.

*Rule* 1. *Parent Structures.* Parent structures (those not considered to be derived from other forms), which need not necessarily have independent existence, have bound to the phosphorus atom the following groups or combinations of groups only:

(*a*) H alone or, in quinquevalent compounds only, in combination with one of the groups (O), (S), (Se), (Te), or (NH), and

(*b*) OH alone or in combination with H, (O), H and (O), =O in tervalent structures, or =O and (O) in quinquevalent structures.

No structure having less than three covalent bonds is named. Omission of bond designation, as in $(HO)_3PO$, or use of parentheses, as in (O), indicates that no differentiation is being made between →O and =O when these satisfy the fourth and fifth valencies of the phosphorus atom. The parent structures are named as follows:

Note 2. The convention has been adopted herein of writing structures with H or R if present, to the left of the P, and all other substituents to the right of the P; where no H or R is present, OH or OR, if present, is written to the left of the P and all other substituents to the right of the P.

*Hydrides*

| | |
|---|---|
| Phosphine | $H_3P$ |
| Phosphine oxide | $H_3PO$ |
| Phosphine sulfide | $H_3PS$ |
| Phosphine selenide | $H_3PSe$ |
| Phosphine telluride | $H_3PTe$ |
| Phosphine imide | $H_3P{:}NH$ |
| Phosphorane | $H_5P$ |

Note 3. The logical name for $H_5P$, phosphane, has been reserved for the system for the polyphosphorus structures.

*Tervalent acids*

| | |
|---|---|
| Phosphorous acid | $(HO)_3P$ |
| Phosphonous acid | $HP(OH)_2$ |
| Phosphinous acid | $H_2P{\cdot}OH$ |
| Phosphenous acid | $HO{\cdot}PO$ |

*Quinquevalent acids*

| | |
|---|---|
| Phosphoric acid | $(HO)_3PO$ |
| Phosphonic acid | $HPO(OH)_2$ |
| Phosphinic acid | $H_2PO{\cdot}OH$ |
| Phosphenic acid | $HO{\cdot}PO(O)$ |
| Phosphoranoic acid | $H_4P{\cdot}OH$ |
| Phosphoranedioic acid | $H_3P(OH)_2$ |
| Phosphoranetrioic acid | $H_2P(OH)_3$ |
| Phosphoranetetroic acid | $HP(OH)_4$ |
| Phosphoranepentoic acid | $(HO)_5P$ |

The following special case is named as indicated:

Phosphonium hydroxide $H_4P^+OH^-$

[Names for compounds in which one or more hydroxyl groups are replaced by acid residues are still under consideration.—ED.]

Note 4. The names of acids recommended above are for the purpose of naming organic compounds of phosphorus. For inorganic chemistry the names approved by the International Union of Chemistry should be used, viz.:

| | | | |
|---|---|---|---|
| $H_3PO_2$ ..... | Hypophosphorous acid | $HPO_3$ ..... | Metaphosphoric acid |
| $H_3PO_3$ ..... | Phosphorous acid | $H_3PO_5$ ..... | Peroxyphosphoric acid |
| $H_3PO_4$ ..... | Phosphoric acid | | |

*Rule* 2. *Structures formed by Substitution.* Structures containing a carbon–phosphorus linkage formed by replacement of H bound to P in any parent structure by a hydrocarbon or heterocyclic group are named by prefixing to the parent name the radical name of the replacing group. Structures formed by replacing two H bound to P in any parent structure not containing an OH group by O, S, Se, Te, or NH are named by prefixing oxo, thiono, selenono, tellurono, or imino to the parent name.

*Examples:*

| | |
|---|---|
| phenylphosphonic acid ..... | $PhPO(OH)_2$ |
| diethylphosphinous acid ..... | $Et_2P{\cdot}OH$ |
| 2-chloroethylphosphine ..... | $H_2P{\cdot}CH_2{\cdot}CH_2Cl$ |
| oxophosphine ..... | HPO |
| thionophosphine sulfide ..... | HPS(S) |

*Rule* 3. *Structures formed by Operation.*

A. Structures formed by the operation of replacing

(1) (O) in a structure containing an OH group bound to P,
(2) (O) and OH simultaneously,
(3) OH, or
(4) the oxygen in OH in a parent or substituted structure by any group *not* cited in Rule 2

are named by insertion of the appropriate affix (in alphabetical order if more than one) just preceding the valency suffix (-ic, -oic, -ous, or -ate, -oate, or -ite) in the parent name. For the sake of euphony, an affix beginning with a consonant is always preceded by "o"; the final "o" is dropped if followed by a vowel. Doubling an affix does not change its alphabetical order. The list of affixes is in the annexed Table.

B. Esters are named by prefixing (separated by a space) to the remainder of the name the hydrocarbon radical name and replacing the ending -ic or -ous acid with -ate or -ite, respectively.

*Example:* diethyl methylphosphonate ..... $MePO(OEt)_2$

Partial esters are named by inserting (separated by spaces) the term "hydrogen" between the ester radical name and the parent name.

*Example:* ethyl hydrogen methylphosphonite ..... $MeP(OH){\cdot}OEt$

The location of substituents in esters containing S and its analogues is denoted by the symbols *O-*, *S-*, *Se-*, and *Te-* prefixed to the radical name; these symbols are used in conjunction with the affix "thio" and its analogues, the affixes "thiolo," "thiono," and their analogues being used only where ambiguity would otherwise result. The symbols *N-* and *P-* are used also where ambiguity arises.

*Examples:*

| | |
|---|---|
| *OO*-diethyl hydrogen phosphorodithioate ..... | $(EtO)_2P(S){\cdot}SH$ |
| *S*-ethyl phosphinothioate ..... | $H_2P(O){\cdot}SEt$ |
| *S*-methyl *NP*-dimethylphosphonamidothioate ..... | $MeP(O)(SMe){\cdot}NHMe$ |
| *O*-ethyl *S*-methyl hydrogen phosphorothiolothionate | $HO{\cdot}P(S)(SMe){\cdot}OEt$ |

*List of affixes*

| Affix | Operation | Name | Structure |
|---|---|---|---|
| amid(o) | Replacement of OH with $NH_2$ | Phosphoramidic acid<br>Phosphoramidimidic acid<br>Phosphoramidochloridic acid | $(HO)_2P(O)\cdot NH_2$<br>$(HO)_2P(:NH)\cdot NH_2$<br>$HO\cdot P(O)Cl(NH_2)$ |
| bromid(o) | Replacement of OH with Br | Phosphonobromidous acid | $HPBr\cdot OH$ |
| chlorid(o) | Replacement of OH with Cl | Phosphorochloridic acid | $(HO)_2P(O)Cl$ |
| cyanatid(o) | Replacement of OH with OCN | Phosphorodicyanatidic acid | $HO\cdot P(O)(OCN)_2$ |
| *iso*cyanatid(o) | Replacement of OH with NCO | Phosphono*iso*cyanatidothionic acid | $HP(S)(NCO)\cdot OH$ |
| cyanid(o) | Replacement of OH with CN | Phosphorochloridocyanidic acid | $HO\cdot P(O)Cl\cdot CN$ |
| fluorid(o) | Replacement of OH with F | Phosphonofluoridic acid | $HP(O)F\cdot OH$ |
| imid(o) | Replacement of (O) with (NH) | Phosphorimidic acid<br>Phosphorimidiodidic acid | $(HO)_3P{:}NH$<br>$(HO)_2P(:NH)I$ |
| iodid(o) | Replacement of OH with I | Phosphorodi-iodidous acid | $HO\cdot PI_2$ |
| nitrid(o) | Replacement of (O) and OH simultaneously with (N) | Phosphononitridic acid | $HP(N)\cdot OH$ |
| thiocyanatid(o) | Replacement of OH with SCN | Phosphorochloridothiocyanatidous acid | $HO\cdot PCl\cdot SCN$ |
| *iso*thiocyanatid(o) | Replacement of OH with NCS | Phosphorimidodi*iso*thiocyanatidic acid | $HO\cdot P(:NH)(NCS)_2$ |
| thio<br>seleno<br>telluro | Replacement of O in OH or (O) with S, Se, or Te, respectively<br>Used in conjunction with letter prefixes *S-*, *Se-*, and *Te-* | See rule 3B | — |
| thiolo<br>selenolo<br>tellurolo | Replacement of O in OH with S, Se, or Te, respectively | See rule 3B | — |
| thiono<br>selenono<br>tellurono | Replacement of (O) with (S), (Se), or (Te), respectively | See rule 3B | — |

---

Salts are named similarly with the cations preceding all other functions.
*Example:*

*O*-sodium *S*-ethyl phosphonothioite ..... $HP(ONa)\cdot SEt$

C. Fully operated structures no longer having acid or ester functions are named according to the *Chemical Abstracts* order of prime functions ("The Naming and Indexing of Chemical Compounds by Chemical Abstracts," paragraph 68, *Chem. Abs.*, 1945, **39**, 5876).
*Examples:*

methylphosphonamidic chloride ..... $MeP(O)Cl\cdot NH_2$
phosphorocyanidous diamide ..... $P(NH_2)_2\cdot CN$

*Rule* 4. *Radicals.*

A. The fundamental radicals attached to another group at the phosphorus atom are named as follows:

| | |
|---|---|
| phosphino | $H_2P$– |
| phosphinyl | $H_2P(O)$– |
| phosphinothioyl | $H_2P(S)$– |
| phosphinimidyl | $H_2P(:NH)$– |
| phosphinonitridyl | $HP(N)$– |
| phosphoranyl | $H_4P$– |

B. Univalent radicals attached to another group at the phosphorus atom are named as compounds of the fundamental radicals. Substituent groups are named in alphabetical order.

*Examples:*

| | |
|---|---|
| chloro(methoxy)phosphino | MeO·P(Cl)– |
| (chloromethoxy)phosphino | $HP(O{\cdot}CH_2Cl)$– |
| hydroxy(methyl)phosphinyl | MeP(O)(OH)– |
| *n*-butylmethylphosphinothioyl | $MeBu^nP(S)$– |
| methylthiophosphinimidyl | HP(:NH)(SMe)– |
| mercapto(methoxy)phosphinyl | MeO·P(O)(SH)– |

C. Bivalent and tervalent radicals formed by the replacement of H with a free valency in a fundamental radical are named

(1) by adding to the final -yl ending the suffix -idene (bivalent) or -idyne (tervalent), or
(2) by dropping the final -o ending and adding the suffix -idene or -idyne.

*Examples:*

| | |
|---|---|
| methoxyphosphinylidene | MeO·P(O)= |
| methoxy(methyl)phosphoranylidyne | MeP(OMe)≡ |
| phosphinidene | HP= |
| phosphinylidyne | P(O)≡ |

D. Compound radicals are named in the usual manner, denoting the phosphorus portions according to Rules 4B and 4C.

*Examples:*

| | |
|---|---|
| dimethoxyphosphinothioyloxy | $(MeO)_2P(S)O$– |
| amino(methyl)phosphinylthio | $MeP(O)(NH_2)S$– |
| methylphosphinothioylamino | MeHP(S)·NH– |

*Extended examples of monophosphorus nomenclature.**

| *Parent structure:* Phosphine $H_3P$ | |
|---|---|
| Oxophosphine | HPO |
| Thionophosphine | HPS |
| Iminophosphine | HP:NH |
| Oxopropylphosphine | $Pr^nPO$ |
| Methyl(methylimino)phosphine | MeP:NMe |
| Methylpropylphosphine | $MePr^nPH$ |
| 2-Chloroethylphosphine | $H_2P{\cdot}CH_2{\cdot}CH_2Cl$ |

| *Parent structure:* Phosphine oxide $H_3PO$ | |
|---|---|
| Oxophosphine oxide | HPO(O) |
| Iminophosphine oxide | HP(O):NH |
| Thionophosphine oxide | HPS(O) |
| Methyloxophosphine oxide | MePO(O) |
| (Ethylimino)methylphosphine oxide | MeP(O):NEt |
| Phenyldipropylphosphine oxide | $PhPr^n{}_2PO$ |

* The "extended examples" are intended to show how names may be derived from the "parent structures." They do not signify that all the names are suitable for all circumstances—indeed in some cases two names are listed for the same substance. Further it is realised that some of the compounds listed are still hypothetical. See also note 4. Ed.

*Parent structure :* Phosphine sulfide $H_3PS$

| | |
|---|---|
| Oxophosphine sulfide | HPO(S) |
| Iminophosphine sulfide | HP(S):NH |
| Thionophosphine sulfide | HPS(S) |
| (2-Chloroethyl)iminophosphine sulfide | Cl·$CH_2$·$CH_2$·P(S):NH |
| Butylethylmethylphosphine sulfide | $Bu^n$EtMeP(S) |

*Parent structure :* Phosphine imide $H_3P(NH)$

| | |
|---|---|
| Oxophosphine imide | HP(O):NH |
| Iminophosphine imide | HP:NH(NH) |
| Thionophosphine imide | HP(S):NH |
| *P*-Methylphosphine imide | $MeH_2P$(:NH) |
| *N*-Methylphosphine imide | $H_3P$(:NMe) |
| Methyliminophosphine imide | HP:NH(:NMe) |
| *P*-Methyl(methylimino)phosphine imide | Me·P:NMe(:NH) |
| *N*-Methyl(methylimino)phosphine imide | HP:NMe(:NMe) |
| *NP*-Dimethyl(methylimino)phosphine imide | Me·P:NMe(:NMe) |
| *PPP*-Trimethylphosphine imide | $Me_3P$(:NH) |
| Tetramethylphosphine imide | $Me_3P$(:NMe) |

*Parent structure :* Phosphorane $H_5P$

| | |
|---|---|
| Oxophosphorane | $H_3PO$ |
| Iminophosphorane | $H_3P$:NH |
| Thionophosphorane | $H_3PS$ |
| 2-Chloroethyloxothionophosphorane | Cl·$CH_2$·$CH_2$·PO(S) |
| Pentaphenylphosphorane | $Ph_5P$ |

*Parent structure :* Phosphoric acid $(HO)_3P(O)$

| | |
|---|---|
| Phosphoramidic acid | $(HO)_2PO·NH_2$ |
| Phosphorodiamidic acid | $HO·PO(NH_2)_2$ |
| Phosphoric triamide (phosphoramide) | $PO(NH_2)_3$ |
| Phosphorochloridic acid | $(HO)_2PO·Cl$ |
| Phosphorodichloridic acid | $HO·POCl_2$ |
| Phosphorothioic acid | *$H_3PO_3S$ |
| Phosphorothionic acid | $(HO)_3PS$ |
| Phosphorothiolic acid | $(HO)_2PO·SH$ |
| Phosphorodithioic acid | *$H_3PO_2S_2$ |
| Phosphorothiolothionic acid | $(HO)_2PS·SH$ |
| Phosphorodithiolic acid | $HO·PO(SH)_2$ |
| Phosphorotrithioic acid | *$H_3POS_3$ |
| Phosphorodithiolothionic acid | $HO·PS(SH)_2$ |
| Phosphorotrithiolic acid | $PO(SH)_3$ |
| Phosphorotetrathioic acid | $PS(SH)_3$ |
| Phosphoramidochloridic acid | $HO·P(O)Cl·NH_2$ |
| Phosphoramidic dichloride | $POCl_2·NH_2$ |
| Phosphorodiamidic chloride | $POCl(NH_2)_2$ |
| Phosphoramidothioic acid | *$H_2PO_2S·NH_2$ |
| Phosphoramidothionic acid | $(HO)_2PS·NH_2$ |
| Phosphoramidothiolic acid | $HO·PO(SH)·NH_2$ |
| Phosphoramidodithioic acid | *$H_2POS_2·NH_2$ |
| Phosphoramidothiolothionic acid | $HO·PS(SH)·NH_2$ |

* Position of S is not known in the free acids. If the position of S is to be designated for purposes of discussion, the " thiolo " or " thiono " names may be used.

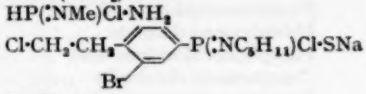
Phosphoramidodithiolic acid ..... $PO(SH)_2 \cdot NH_2$
Phosphoramidotrithioic acid ..... $PS(SH)_2 \cdot NH_2$
Phosphorodiamidothioic acid ..... $^{\bullet}HPOS(NH_2)_2$
Phosphorodiamidothionic acid ..... $HO \cdot PS(NH_2)_2$
Phosphorodiamidothiolic acid ..... $PO(NH_2)_2 \cdot SH$
Phosphorodiamidodithioic acid ..... $PS(NH_2)_2 \cdot SH$
Phosphorothioic triamide ..... $PS(NH_2)_3$
Phosphorochloridothioic acid ..... $^{\bullet}H_2PO_2SCl$
Phosphorochloridothionic acid ..... $(HO)_2PSCl$
Phosphorochloridothiolic acid ..... $HO \cdot PO(Cl) \cdot SH$
Phosphorochloridodithioic acid ..... $^{\bullet}H_2POS_2Cl$
Phosphorochloridothiolothionic acid ..... $HO \cdot P(S)Cl \cdot OH$
Phosphorochloridodithiolic acid ..... $POCl(SH)_2$
Phosphorochloridotrithioic acid ..... $PSCl(SH)_2$
Phosphorodichloridothioic acid ..... $^{\bullet}HPOSCl_2$
Phosphorodichloridothionic acid ..... $HO \cdot PSCl_2$
Phosphorodichloridothiolic acid ..... $POCl_2 \cdot SH$
Phosphorodichloridodithioic acid ..... $PSCl_2 \cdot SH$
Phosphoramidochloridothioic acid ..... $^{\bullet}HPOS(Cl) \cdot NH_2$
Phosphoramidochloridothionic acid ..... $HO \cdot PS(Cl) \cdot NH_2$
Phosphoramidochloridothiolic acid ..... $POCl(NH_2) \cdot SH$
Phosphoramidochloridodithioic acid ..... $PSCl(NH_2) \cdot SH$
Phosphoramidothioic dichloride ..... $PSCl_2 \cdot NH_2$
Phosphorodiamidothioic chloride ..... $PSCl(NH_2)_2$
Phosphorimidic acid ..... $(HO)_3P(:NH)$
Phosphoramidimidic acid ..... $(HO)_2P(:NH) \cdot NH_2$
Phosphorodiamidimidic acid ..... $HO \cdot P(:NH)(NH_2)_2$
Phosphorimidic triamide ..... $P(:NH)(NH_2)_3$
Phosphorochloridimidic acid ..... $(HO)_2P(:NH)Cl$
Phosphorodichloridimidic acid ..... $HO \cdot P(:NH)Cl_2$
Phosphorimidic trichloride ..... $P(:NH)Cl_3$
Phosphorimidothioic acid ..... $(HO)_2P(:NH) \cdot SH$
Phosphorimidodithioic acid ..... $HO \cdot P(:NH)(SH)_2$
Phosphorimidotrithioic acid ..... $P(:NH)(SH)_3$
Phosphoramidimidothioic acid ..... $HO \cdot P(:NH)(SH)(NH_2)$
Phosphorodiamidimidothioic acid ..... $P(:NH)(NH_2)_2 \cdot SH$
Phosphoramidimidodithioic acid ..... $P(:NH)(HS)_2 \cdot NH_2$
Phosphoramidochloridimidic acid ..... $HO \cdot P(:NH)(Cl) \cdot NH_2$
Phosphorodiamidimidic chloride ..... $P(:NH)Cl(NH_2)_2$
Phosphoramidimidic dichloride ..... $P(:NH)Cl_2 \cdot NH_2$
Phosphoramidochloridimidothioic acid ..... $P(:NH)Cl(NH_2) \cdot SH$
Phosphorochloridimidothioic acid ..... $HO \cdot P(:NH)Cl \cdot SH$
Phosphorochloridimidodithioic acid ..... $P(:NH)Cl(SH)_2$
Phosphorodichloridimidothioic acid ..... $P(:NH)Cl_2 \cdot SH$
Phosphoronitridic acid ..... $(HO)_3PN$
Phosphoramidonitridic acid ..... $HO \cdot PN \cdot NH_2$
Phosphoronitridic diamide ..... $PN(NH_2)_2$
Phosphorochloridonitridic acid ..... $HO \cdot PNCl$
Phosphoronitridothioic acid ..... $HO \cdot PN \cdot SH$
Phosphoronitridodithioic acid ..... $PN(SH)_2$
Phosphoramidonitridic chloride ..... $PNCl \cdot NH_2$
Phosphoramidonitridothioic acid ..... $PN(NH_2) \cdot SH$
Phosphorochloridonitridothioic acid ..... $PNCl \cdot SH$
Phosphorobromidic acid ..... $(HO_2)POBr$
Phosphorocyanatidic acid ..... $(HO)_2PO \cdot OCN$
Phosphorocyanidic acid ..... $(HO)_2PO \cdot CN$
Phosphorofluoridic acid ..... $(HO)_2POF$
Phosphoriodidic acid ..... $(HO)_2POI$
Phosphor*iso*cyanidic acid ..... $(HO)_2PO \cdot NC$
Phosphor*iso*cyanatidic acid ..... $(HO)_2PO \cdot NCO$

| | |
|---|---|
| Phosphoro(thiocyanatidic) acid | $(HO)_2PO{\cdot}SCN$ |
| Phosphor(*iso*thiocyanatidic) acid | $(HO)_2PO{\cdot}NCS$ |
| Phosphorochloridofluoridic acid | $HO{\cdot}POClF$ |
| Phosphoramidodithio(thiocyanatidic) acid | $PS(NH_2)(SCN){\cdot}SH$ |
| Methyl hydrogen phosphoramidate | $HO{\cdot}PO(OMe){\cdot}NH_2$ |
| Methyl hydrogen methylphosphoramidate | $HO{\cdot}PO(OMe){\cdot}NHMe$ |
| Dimethyl dimethylphosphoramidate | $PO(OMe)_2{\cdot}NMe_2$ |
| *OS*-Diethyl *O*-hydrogen phosphorodithioate | $HO{\cdot}PS(OEt){\cdot}SEt$ |
| *N*-Methylphosphoramidimidic acid | $(HO)_2P(:NH){\cdot}NHMe$ |
| *N'*-Methylphosphoramidimidic acid | $(HO)_2P(:NMe){\cdot}NH_2$ |
| *NN'*-Dimethylphosphorodiamidimidic acid | $HO{\cdot}P(:NH)(NHMe)_2$ |
| *NN''*-Dimethylphosphorodiamidimidic acid | $HO{\cdot}P(:NMe)(NHMe){\cdot}NH_2$ |
| Dimethyl phosphorochloridate | $POCl(OMe)_2$ |
| *OO*-Diethyl *O*-*p*-nitrophenyl phosphorothioate | $p\text{-}NO_2{\cdot}C_6H_4{\cdot}O{\cdot}PS(OEt)_2$ |
| Ethyl methylphosphoramidonitridate | $EtO{\cdot}PN{\cdot}NHMe$ |

*Parent structure :* Phosphonic acid $HP(O)(OH)_2$

| | |
|---|---|
| Phosphonamidic acid | $HPO(NH_2){\cdot}OH$ |
| Phosphonic diamide (phosphonamide) | $HPO(NH_2)_2$ |
| Phosphonochloridic acid | $HPOCl{\cdot}OH$ |
| Phosphonic dichloride | $HPOCl_2$ |
| Phosphonothioic acid | $*H_3PO_2S$ |
| Phosphonothionic acid | $HPS(OH)_2$ |
| Phosphonothiolic acid | $HPO(SH){\cdot}OH$ |
| Phosphonodithioic acid | $*H_3POS_2$ |
| Phosphonothiolothionic acid | $HPS(SH){\cdot}OH$ |
| Phosphonodithiolic acid | $HPO(SH)_2$ |
| Phosphonotrithioic acid | $HPS(SH)_2$ |
| Phosphonamidic chloride | $HPOCl{\cdot}NH_2$ |
| Phosphonamidothioic acid | $*H_2POS{\cdot}NH_2$ |
| Phosphonamidothionic acid | $HPS(NH_2){\cdot}OH$ |
| Phosphonamidothiolic acid | $HPO(NH_2){\cdot}SH$ |
| Phosphonothioic diamide | $HPS(NH_2)_2$ |
| Phosphonamidodithioic acid | $HPS(NH_2){\cdot}SH$ |
| Phosphonochloridothioic acid | $*H_2POSCl$ |
| Phosphonochloridothionic acid | $HPSCl{\cdot}OH$ |
| Phosphonochloridothiolic acid | $HPOCl{\cdot}SH$ |
| Phosphonothioic dichloride | $HPSCl_2$ |
| Phosphonochloridodithioic acid | $HPSCl{\cdot}SH$ |
| Phosphonamidothioic chloride | $HPSCl{\cdot}NH_2$ |
| Phosphonimidic acid | $HP(:NH)(OH)_2$ |
| Phosphonamidimidic acid | $HP(:NH)(NH_2){\cdot}OH$ |
| Phosphonimidic diamide | $HP(:NH)(NH_2)_2$ |
| Phosphonochloridimidic acid | $HP(:NH)Cl{\cdot}OH$ |
| Phosphonimidic dichloride | $HP(:NH)Cl_2$ |
| Phosphonimidothiolic acid | $HP(:NH)(SH){\cdot}OH$ |
| Phosphonimidodithioic acid | $HP(:NH)(SH)_2$ |
| Phosphonamidimidothioic acid | $HP(:NH)(NH_2){\cdot}SH$ |
| Phosphonamidimidic chloride | $HP(:NH)Cl{\cdot}NH_2$ |
| Phosphonochloridimidothioic acid | $HP(:NH)Cl{\cdot}SH$ |
| Phosphononitridic acid | $HPN{\cdot}OH$ |
| Phosphononitridic amide | $HPN{\cdot}NH_2$ |
| Phosphononitridic chloride | $HPNCl$ |
| Phosphononitridothioic acid | $HPN{\cdot}SH$ |
| Phosphonocyanidic acid | $HPO(CN){\cdot}OH$ |
| Phosphonic bromide fluoride | $HPOBrF$ |
| Methyl hydrogen ethylphosphonate | $EtPO(OMe){\cdot}OH$ |
| Methyl *P*-methylphosphonamidate | $MePO(NH_2){\cdot}OMe$ |

*S*-Methyl *NP*-dimethylphosphonamidothioate ... $MePO(NHMe)\cdot SMe$
Methyl trimethylphosphonamidodithioate ..... $MePS(NMe_2)\cdot SMe$
*N'*-Methylphosphonamidimidic chloride ..... $HP(:NMe)Cl\cdot NH_2$
Sodium *N*-amyl-*P*-(3-bromo-4-2'-chloroethyl)-phenylphosphonochloridimidothioate .....




Phenylphosphonic acid ..... $PhPO(OH)_2$
Dimethyl diphenylphosphonimidate ..... $PhP(:NPh)(OMe)_2$
Dimethyl *N*-ethyl-*P*-methylphosphonimidate ..... $MeP(:NEt)(OMe)_2$

*Parent structure :* Phosphinic acid $H_2PO\cdot OH$

Phosphinic amide (phosphinamide) ..... $H_2PO\cdot NH_2$
Phosphinic chloride ..... $H_2POCl$
Phosphinothioic acid ..... $H_2POS$
Phosphinothionic acid ..... $H_2PS\cdot OH$
Phosphinothiolic acid ..... $H_2PO\cdot SH$
Phosphinodithioic acid ..... $H_2PS\cdot SH$
Phosphinothioic amide ..... $H_2PS\cdot NH_2$
Phosphinothioic chloride ..... $H_2PSCl$
Phosphinimidic acid ..... $H_2P(:NH)\cdot OH$
Phosphinimidic amide ..... $H_2P(:NH)\cdot NH_2$
Phosphinimidic chloride ..... $H_2P(:NH)Cl$
Phosphinimidothioic acid ..... $H_2P(:NH)\cdot SH$
Phosphinic nitride (phosphiminitride) ..... $H_2PN$
*NP*-Dimethylphosphinic amide (*NP*-dimethylphosphinamide) ..... $MeHPO\cdot NHMe$
Tetramethylphosphinic amide (tetramethylphosphinamide) ..... $Me_2PO\cdot NMe_2$
Methyl *N*-methylphosphinimidate ..... $H_2P(:NMe)\cdot OMe$
*S*-Methyl phosphinothioate ..... $H_2PO\cdot SMe$
Diphenylphosphinic nitride (diphenyl phosphinitride) ..... $Ph_2PN$

*Parent structure :* Phosphorous acid $(HO)_3P$

Phosphoramidous acid ..... $(HO)_2P\cdot NH_2$
Phosphorodiamidous acid ..... $HO\cdot P(NH_2)_2$
Phosphorous triamide ..... $P(NH_2)_3$
Phosphorochloridous acid ..... $(HO)_2PCl$
Phosphorodichloridous acid ..... $HO\cdot PCl_2$
Phosphorothious acid ..... $(HO)_2P\cdot SH$
Phosphorodithious acid ..... $HO\cdot P(SH)_2$
Phosphorotrithious acid ..... $P(SH)_3$
Phosphoramidochloridous acid ..... $HO\cdot PCl\cdot NH_2$
Phosphoramidous dichloride ..... $PCl_2\cdot NH_2$
Phosphorodiamidous chloride ..... $PCl(NH_2)_2$
Phosphoramidothious acid ..... $HO\cdot P(SH)\cdot NH_2$
Phosphoramidodithious acid ..... $P(NH_2)(SH)_2$
Phosphorodiamidothious acid ..... $P(NH_2)_2\cdot SH$
Phosphorochloridothious acid ..... $HO\cdot PCl\cdot SH$
Phosphorodichloridothious acid ..... $PCl_2\cdot SH$
Phosphorochloridodithious acid ..... $PCl(SH)_2$
Phosphoramidochloridothious acid ..... $PCl(NH_2)\cdot SH$
Methyl dimethylphosphoramidochloridite ..... $PCl(NMe_2)\cdot OMe$
Methyl *NN'*-dimethylphosphorodiamidothioite ... $P(NHMe)_2\cdot SMe$

*Parent structure :* Phosphonous acid $HP(OH)_2$

| | |
|---|---|
| Phosphonamidous acid | $HP(OH)\cdot NH_2$ |
| Phosphonous diamide | $HP(NH_2)_2$ |
| Phosphonochloridous acid | $HPCl\cdot OH$ |
| Phosphonous dichloride | $HPCl_2$ |
| Phosphonothious acid | $HP(SH)\cdot OH$ |
| Phosphonodithious acid | $HP(SH)_2$ |
| Phosphonamidous chloride | $HPCl\cdot NH_2$ |
| Phosphonamidothious acid | $HP(NH_2)\cdot SH$ |
| Phosphonamidothious acid | $HP(NH_2)\cdot SH$ |
| Phosphonochloridothious acid | $HPCl\cdot SH$ |
| Dimethyl phenylphosphonodithioite | $PhP(SMe)_2$ |
| Methyl *NP*-dimethylphosphonamidite | $MeP(NHMe)\cdot OMe$ |
| Methyl phenylphosphonochloridite | $PhPCl\cdot OMe$ |

*Parent structure :* Phosphinous acid $H_2P\cdot OH$

| | |
|---|---|
| Phosphinous amide | $H_2P\cdot NH_2$ |
| Phosphinous chloride | $H_2PCl$ |
| Phosphinothious acid | $H_2P\cdot SH$ |
| Tetramethylphosphinous amide | $Me_2P\cdot NMe_2$ |
| Methyl phosphinothioite | $H_2P\cdot SMe$ |
| Ethylmethylphosphinous chloride | EtMePCl |

*Parent structure :* Phosphenic acid $HO\cdot PO_2$

| | |
|---|---|
| Phosphenic amide (phosphenamide) | $PO_2\cdot NH_2$ |
| Phosphenothioic acid | $*HPO_2S$ |
| Phosphenothionic acid | $HO\cdot POS$ |
| Phosphenothiolic acid | $PO_2\cdot SH$ |
| Phosphenodithioic acid | $*HPOS_2$ |
| Phosphenothiolothionic acid | $POS\cdot SH$ |
| Phosphenodithionic acid | $HO\cdot PS_2$ |
| Phosphenotrithioic acid | $PS_2\cdot SH$ |
| Phosphenothioic amide | $POS\cdot NH_2$ |
| Phosphenodithioic amide | $PS_2\cdot NH_2$ |
| Phosphenimidic acid | $HO\cdot P(O){:}NH$ |
| Phosphenodi-imidic acid | $HO\cdot P(NH)_2$ |
| Phosphenimidic chloride | $HO\cdot P(O){:}NH$ |
| Phosphenodi-imidic chloride | $PCl({:}NH)_2$ |
| Phosphenimidothioic acid | $*HPOS{:}NH$ |
| Phosphenimidothionic acid | $HO\cdot P(S){:}NH$ |
| Phosphenimidothiolic acid | $PO({:}NH)\cdot SH$ |
| Phosphenimidodithioic acid | $PS({:}NH)\cdot SH$ |
| Phosphenodi-imidothioic acid | $P({:}NH)_2\cdot SH$ |
| Phosphenimidic amide | $PO({:}NH)\cdot NH_2$ |
| Phosphenodi-imidic amide | $P({:}NH)_2\cdot NH_2$ |
| Phosphenimidothioic amide | $PS({:}NH)\cdot NH_2$ |
| Phosphenimidothioic chloride | $P(S)Cl{:}NH$ |
| Phosphenimidic nitride | $PN({:}NH)$ |
| Methylphosphenic amide | $PO_2\cdot NHMe$ |
| *O*-Methyl phosphenothioate | $MeO\cdot POS$ |
| Methylphosphenodi-imidic acid | $HO\cdot P({:}NH)(NMe)$ |
| Butyl phosphenate | $BuO\cdot PO_2$ |
| *NN'N''*-Trimethylphosphenodi-imidic amide | $P({:}NMe)_2\cdot NHMe$ |
| Methyl phosphenimidate | $MeO\cdot P(O){:}NH$ |

*Parent structure :* Phosphenous acid HO·PO

| | |
|---|---|
| Phosphenous amide | PO·$NH_2$ |
| Phosphenothious acid | *HPOS |
| Phosphenothionous acid | HO·PS |
| Phosphenothiolous acid | PO·SH |
| Phosphenodithious acid | PS·SH |
| Phosphenothious amide | PS·$NH_2$ |
| Phosphenimidous acid | HO·P:NH |
| Phosphenimidous amide | P(:NH)·$NH_2$ |
| Phosphenimidous chloride | PCl:NH |
| Phosphenimidothious acid | P(:NH)·SH |
| *S*-Methyl phosphenothioite | PO·SMe |
| Methyl phosphenite | MeO·PO |
| *N*-Methylphosphenimidous amide | P(:NH)·NHMe |
| *N'*-Methylphosphenimidous amide | P(:NMe)·$NH_2$ |

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## ERRATA

Vol. 1947, page 1463, line 6. *For* 2 *read* 5.

---

Vol. 1948, page 994, line 19. *For* $10^{-4}$ *read* $IO_4^-$.

---

Vol. 1948, page 1719, line 20. For *Chem. Zentr.* read *Chem. Ztg.*

---

Vol. 1949, page 1540, line 8 of text. *For* Montgomery *read* McDonald.

---

Vol. 1949, page 3431, line 33. *For* 80 *read* 480.

---

Vol. 1950, page 383, line 7*. *For* $\varepsilon_{calc.} = 0{\cdot}87 \times 2 \times 10^{20}n = 1{\cdot}74 \times 10^{20}n$ *read* $\varepsilon_{calc.} = 0{\cdot}87 \times 2 \times 10^{20} \times 10^{-16}n = 1{\cdot}74 \times 10^{4}n$.

---

Vol. 1950, page 456, Table III, compound (46). For 4-*Chloro*-2-*methylthio*-6-*methyl*- read 4-*Chloro*-5-*methyl*-2-*methylthio*-.

---

Vol. 1951, page 1444, line 13*. *For* 260 *read* 26.

---

Vol. 1951, page 1449, line 1. *For* 260 *read* 26.

---

Vol. 1951, page 1515, line 8*. *For* 4-formyl-3 : 5-dimethylphenol *read* 2-formyl-3 : 5-dimethylphenol.

---

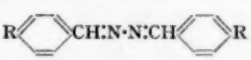
Vol. 1951, page 1599, line 8*. For 2-*Di*-p-*dimethylaminophenyl*-2-*methylpropan*-1-*one* read 1 : 2-*Di*-p-*dimethylaminophenyl*-2-*methylpropan*-1-*one*.

---

Vol. 1951, page 2089, line 9*. *For* $X^-{=}CH{-}CH{=}CR_2\ OH^+$ *read* $^+X{=}CH{-}CH{=}CR_2\ OH^-$.

---

Vol. 1951, page 2202. Formula (VI) *should read*

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Vol. 1951, page 2340, Table I, first column, third line. *For* 70·00° *read* 70·80°.

---

Vol. 1951, page 2344, Table I. *For* $R = NH_2$ * *read* $R = H$ *.

---

Vol. 1951, page 2570, line 21*. *For* $[\alpha]_D^{25}$ +70·5° *read* $[\alpha]_D^{25}$ −26·1°.

---

Vol. 1951, page 2844, Fig. 1. The caption at the top of the figure should read [NOCl *concn.*]$^3$. *Curve B.*

---

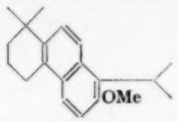
Vol. 1951, page 2960. Eqn. 10 *should read*

$$x_B^* = n_B^*/(n_A^* + n_B^*)$$
$$= \frac{A(x_B + \Delta x_B) - a_A(n_A + n_B)\Delta x_B}{A + (n_A + n_B)(a_B - a_A)\Delta x_B}$$

* From bottom.

# *Errata*

Vol. 1951, page 2979. Formula (II) *should read*




Vol. 1951, page 3060, line 13*. *For* Na[Ln enta],$H_4$enta *read* 4Na[Ln enta],$H_4$enta.

Vol. 1951, page 3089, line 3*. *For* reaction *read* relation.

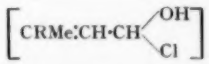
Vol. 1951, page 3091, line 12. *For* $(\partial P/\partial T)_T$ read $(\partial P/\partial T)_V$.

Vol. 1951, page 3092, line 28. *For* syphon *read* sylphon.

Vol. 1951, page 3163, line 5. *After* R·CH(OH)·CHR′·COR″ *insert* + B.

Vol. 1951, page 3166, lines 4 and 5. *Should read* Glycine ethyl ester hydrochloride was condensed with acetylacetone in buffer solution. On account of the appreciable solubility of the product in water, excess of the buffer could not be .

Vol. 1951, page 3256. The formula between (VII) and (VI) *should read*




Vol. 1951, page 3345, line 21*. For *J.*, 1947, read *J.*, 1948.

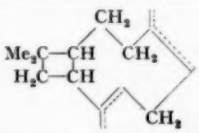
Vol. 1951, page 3363, line 7. *For* Overend and Peacocke's *read* Gulland, Jordan, and Taylor's.

Vol. 1951, page 3366, line 25. *For* method *read* workers.

Vol. 1951, page 3367, Table I, in footnotes. *For* * *read* †, *for* † *read* ‡, *and for* ‡ *read* *.

Vol. 1951, page 3368, line 20. *For* (1 and 2) *read* (Figs. 1 and 2).

Vol. 1951, page 3384. Formula (VI) *should read*




Vol. 1951, page 3420, line 7. *For* Franzel *read* Franzen.

Vol. 1951, page 3432, line 14. *For* $OEt^b$ H *read* H $OEt^b$.

Vol. 1951, page 3432, footnotes to Table I. *After* 1199 *insert* , acetylated phenetole.

Vol. 1951, page 3498, line 10*. *For* 10 *read* 20.

Vol. 1952, page 158, line 6*. *For* (+)-*cis*-*p*-menth-2-ene *read* (+)-*p*-menth-3-ene.

* From bottom.

# *Errata*

Vol. 1952, page 219. The numbers (X) and (XI) should be below the second and the fourth formula, respectively. The double arrow between the third and the fourth formula should be replaced by a double-headed arrow ⟷.

Vol. 1952, page 234, line 11* should read *Reactions with Thioglycollic Acid.*—(*a*) 2 : 5-Dihydrothiophen gave a *disulphide* (31%) as an orange, viscous oil, b. p. 175—180°/3 mm., $n_D^{20}$ 1·5760 (Found : C, 39·9; H, 5·6; S, 36·7. $C_8H_{10}O_2S_2$ requires C, 40·4; H, 5·65; S, 36·0%). This afforded a *disulphone* as a benzene-.

Vol. 1952, page 275, line 23*. *For* 15 000 *read* 13 000.

Vol. 1952, page 275, line 12*. *For* 14 000 *read* 13 000.

Vol. 1952, page 275, last line. *For* 10 000 *read* 9000, *and for* 12 500 *read* 11 500.

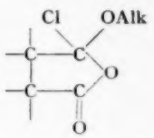
Vol. 1952, page 276, line 3. *For* 7000 *read* 6500.

Vol. 1952, page 380, line 8. *Delete* , m. p. 28°.

Vol. 1952, page 438, line 14. For (*Gazzetta*, 1943, **73**, 313) read (*Gazzetta*, 1939, **69**, 86).

Vol. 1952, page 439, line 6. *For* 1941, **64**, 1696 *read* 1942, **64**, 1696.

Vol. 1952, page 563. Formula (LX) should be




Vol. 1952, page 683, line 30. *For* 122—113° *read* 112—113°.

Vol. 1952, page 727, line 29*. *For* α-amylase *read* β-amylase.

Vol. 1952, page 813, line 7*. For *loc. cit.*, p. 1220 *read J.*, 1936, 1220.

Vol. 1952, page 1043, line 2. *For* α-picrototinic *read* α-picrotinic.

Vol. 1952, page 1100. In Formula (XXI) *insert* a line representing a 6-methyl group.

Vol. 1952, page 1129. Fig., the legends for *A* and *B* should be transposed.

Vol. 1952, page 1251, line 16* (title). For *Chloroundecafluoro*cyclo*hexanes* read *Perfluorinated Chloro*-cyclo*hexanes*.

Vol. 1952, page 1368, footnote. *For* 1951 *read* 1952.

Vol. 1952, page 1427, line 10*. *For* 1660 cm.$^{-1}$ *read* 817 cm.$^{-1}$.

* From bottom.

# *Errata*

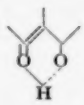
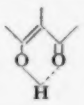
Vol. 1952, page 1506, line 11. *For* 144° *read* 134°.

Vol. 1952, page 1674, Table 1. For 2-Methyl-*n*-butyl fluoride, b. p./mm. should read 56·2°/757.

Vol. 1952, page 1892, line 6. For *nitramides* read *nitramines*.

Vol. 1952, page 2245, line 19*. *For* cyclo*Hexene read* cyclo*Hexane*.

Vol. 1952, page 2666, line 14*. For 3 : 7-*Dimethyl*-9-(2 : 6 : 6-*trimethyl*cyclo*hex*-1-*enyl*)-2 : 4 : 6 : 8-*tetraenoate* read 3 : 7-*Dimethyl*-9-(2 : 6 : 6-*trimethyl*cyclo*hex*-1-*enyl*)*nona*-2 : 4 : 6 : 8-*tetraenoate*.

Vol. 1952, page 2762, formula (XII). *For*  *read* 

Vol. 1952, page 2966, line 5*. For *ibid.*, 1950, **72**, 67 read *ibid.*, 1950, **72**, 3030.

Vol. 1952, page 2966, last line. For *loc. cit.* read *ibid.*, p. 67.

Vol. 1952, page 2968, legend to Fig. 3. *For* 3·35 ± 0·05 × $10^{-3}$M *read* 3·35 ± 0·05 × $10^{-2}$M.

Vol. 1952, page 3067, line 23*. *For* 0·04 g. *read* 0·4 g.

Vol. 1952, page 3374, Title and throughout the paper. *For* 2 : 3-*seco*cholestane-2 : 3-dicarboxylic acid *read* 2 : 3-*seco*cholestane-2 : 3-dioic acid (similarly for its derivatives).

Vol. 1952, page 3723, Table I, heading of eighth column. *After* Δλ *insert* , Å.

Vol. 1952, page 3725, Table II, heading of seventh column. *After* Δλ *insert* , Å.

Vol. 1952, page 3782, line 9. For *Phenyl*-p-*tolylmethylphosphonic* read *Phenyldi*-p-*tolylmethylphosphonic*.

Vol. 1952, page 4025, line 20. *After* 1-benzylaminonaphthalene *add* (23·3 g., 0·1 mol.).

Vol. 1952, page 4083. In Formula. *For* $CH_2$:CR″·$CH_2$·O·CHR·CHR″·CHO *read* $CH_2$:CR″·$CH_2$·O·CHR·CHR′·CHO.

Vol. 1952, page 4090, line 5*. *For* 35 *read* 40.

Vol. 1952, page 4111, Table 2. *Raise* (Va) *two lines*, i.e., *level with* [from degradation of (II)].

Vol. 1952, page 4220, Table I, No. 12.
Vol. 1952, page 4225, line 7 (twice). } *For* 8-methyl *read* *N*-methyl.

Vol. 1952, page 4522, line 12*. *For* dianthronyl *read* dianthron-9-ylidene.

* From bottom.

# *Errata*

Vol. 1952, page 4528, line 8*. *For* carbon dioxide *read* carbon dioxide-free nitrogen.

Vol. 1952, page 4567, line 20*. *For* 75,000 *read* 7500, *and for* 72,500 *read* 7250.

Vol. 1952, page 4582, line 6*. *For* 132—133° *read* 136—137°.

Vol. 1952, page 4583, line 11. *For* N, 5·6% *read* N, 4·6%.

Vol. 1952, page 4636, Table 2, the first italicized centre heading. For 4-(3-*Methylbenzothiazolin*-2-*ylidene*)-2-*thiazolid*-5-*ones* read 4-(3-*Methylbenzothiazolin*-2-*ylidene*)-2-*thiothiazolid*-5-*ones*.

Vol. 1952, page 4701, line 15. *For* 4 : 9-diamino-2 : 6-diazapyrene *read* 4 : 9-diamino-2 : 7-diphenyl-1 : 6-diazapyrene.

Vol. 1952, page 4754, line 26. For 2 : 4-*Dimethoxybenzyl* 2-*Hydroxy*-4 : 6-*dimethoxybenzyl Ketone* read 2 : 4-*Dimethoxybenzyl* 2-*Hydroxy*-4 : 6-*dimethoxyphenyl Ketone*.

Vol. 1952, page 4755, line 27*. *After* H, 6·2 *insert* ; 2OMe, 31·7.

Vol. 1952, page 4755, line 16*. *For* 4-Ethoxy-2-methoxybenzoic acid (1 g.) *read* 4-Ethoxy-2-hydroxybenzoic acid (1 g.).

Vol. 1952, page 4889, line 26*. *For* $C_{31}H_{21}O_3$ *read* $C_{30}H_{50}O_3$.

Vol. 1952, page 4890, line 6. *For* 3β-acetoxy-5α : 8α-epidioxyergost-9 : 22-ene *read* 3β-acetoxy-5α : 8α epidioxyergosta-9 : 22-diene.

Vol. 1952, page 4890, line 7. *For* uptake of 2 *read* uptake of 3.

* From bottom.

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